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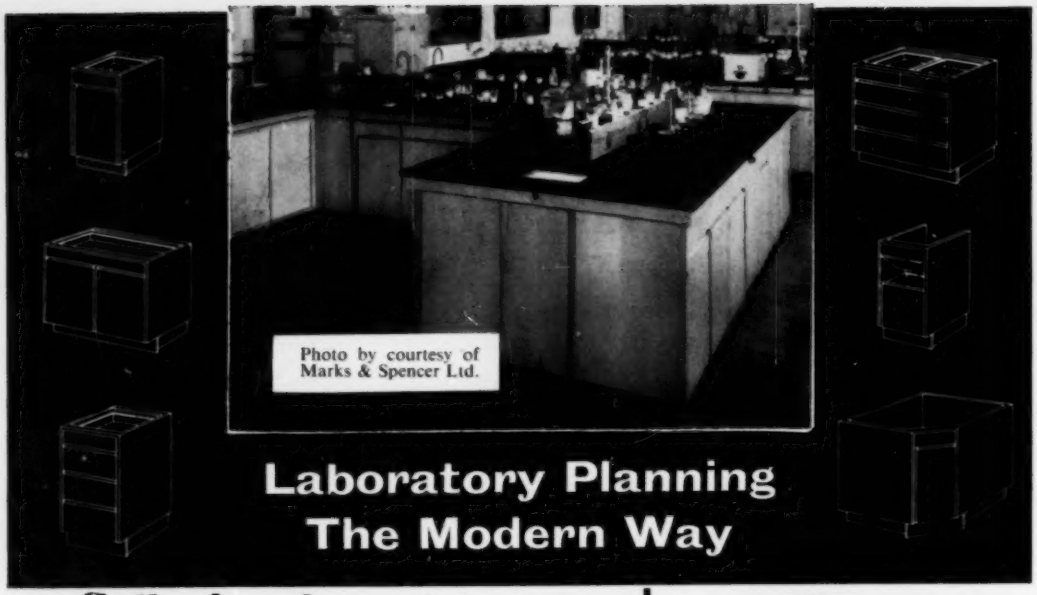

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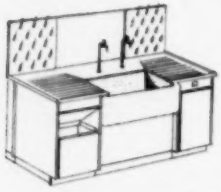

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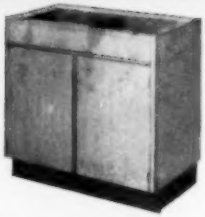

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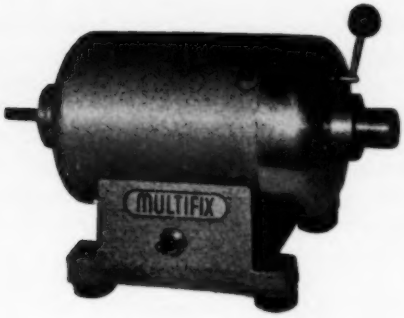

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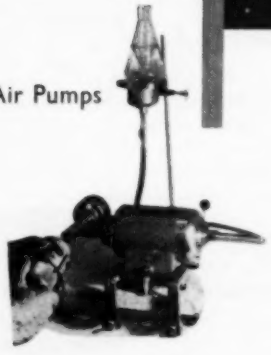

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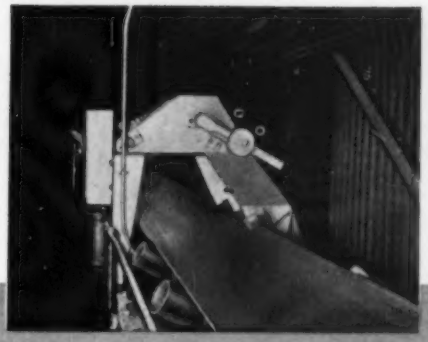

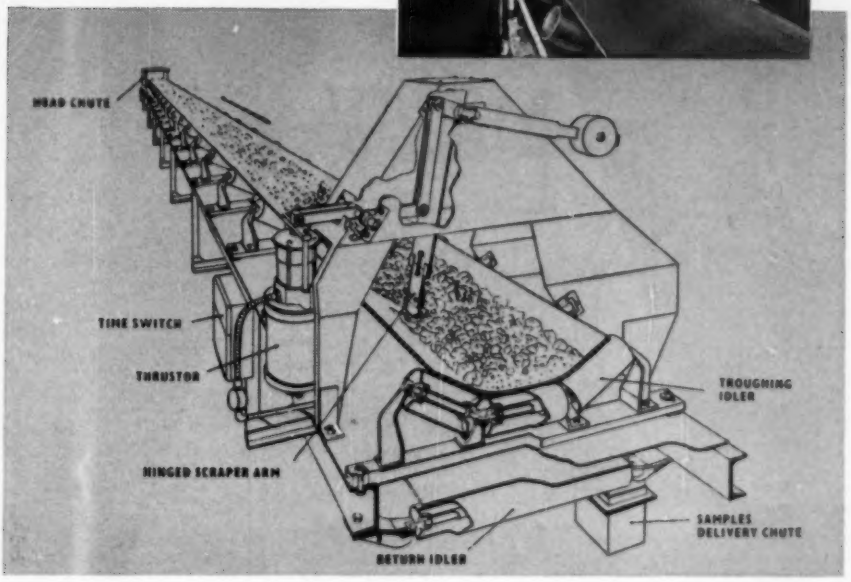

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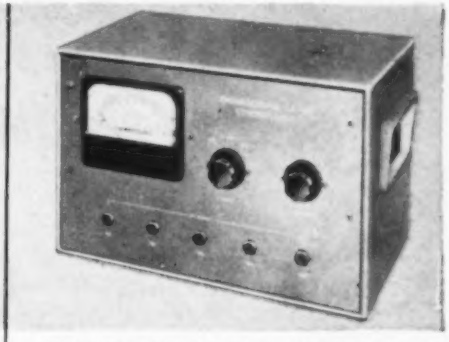

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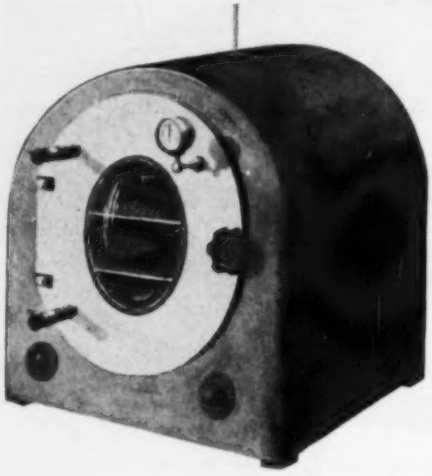

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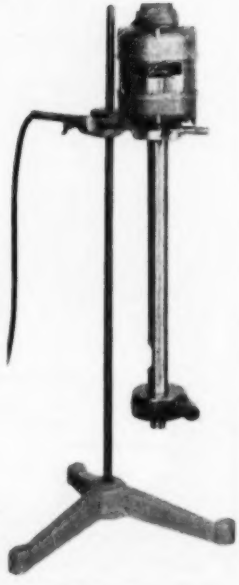

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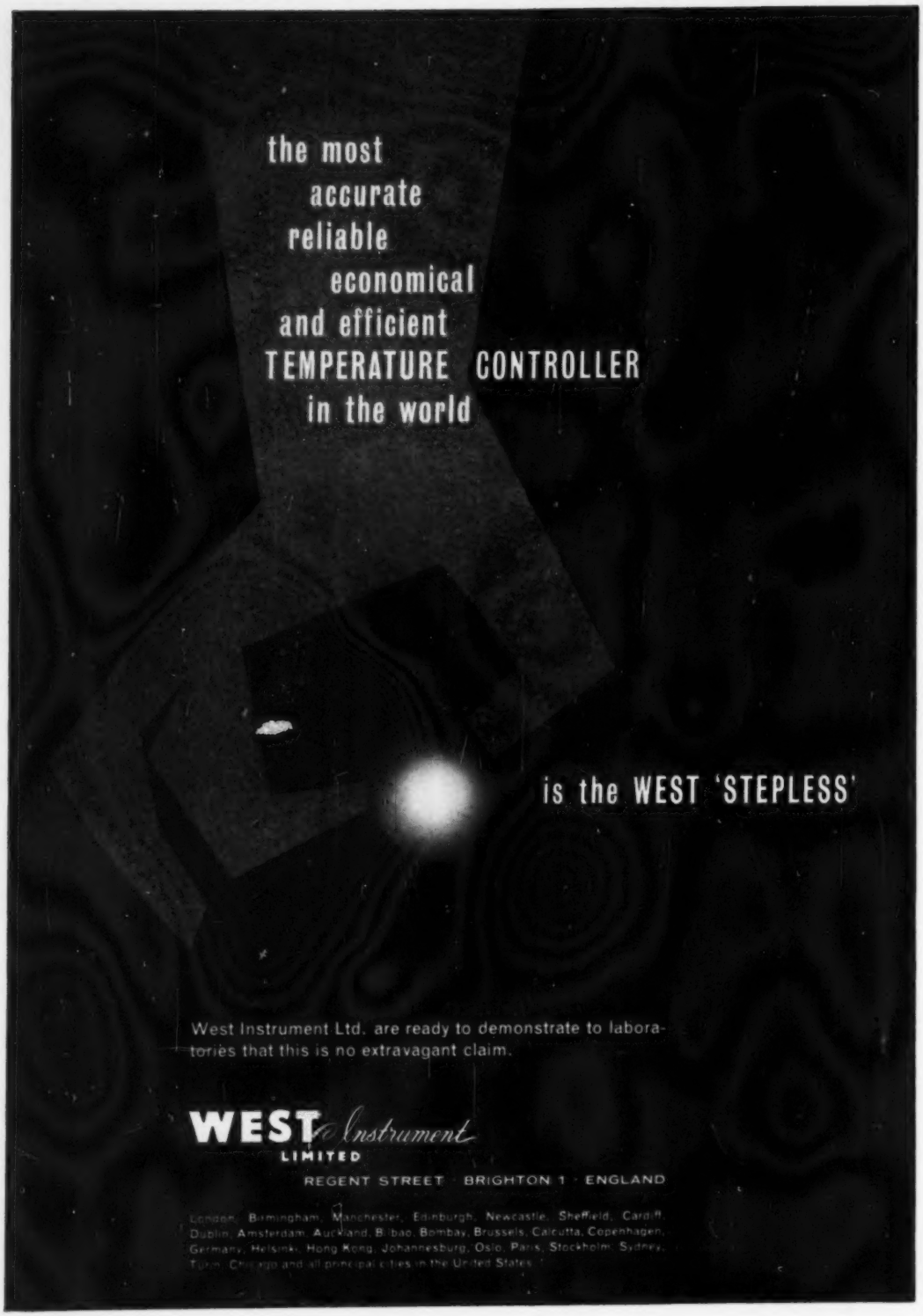
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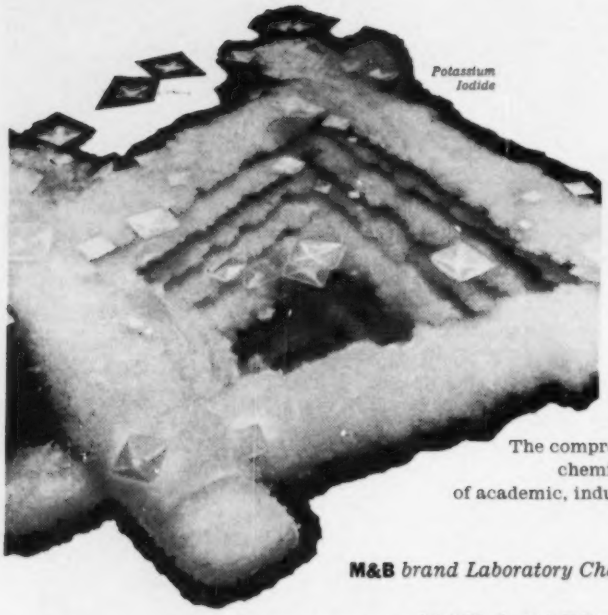

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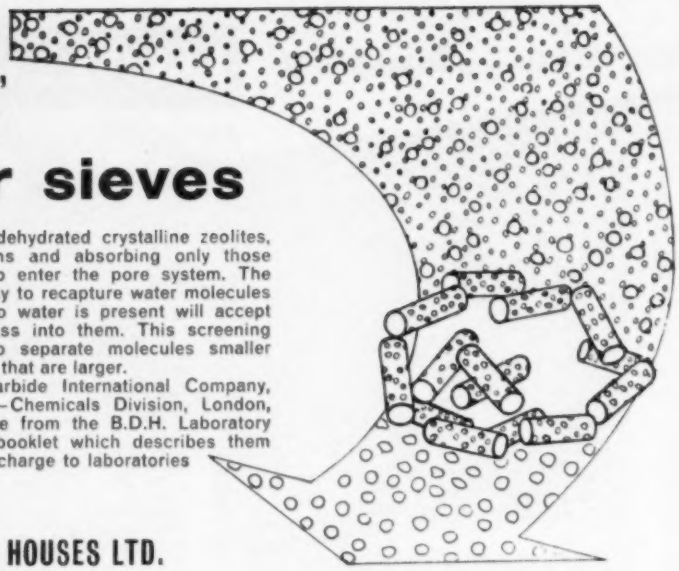

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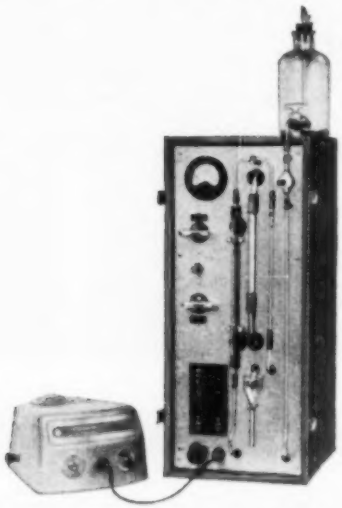

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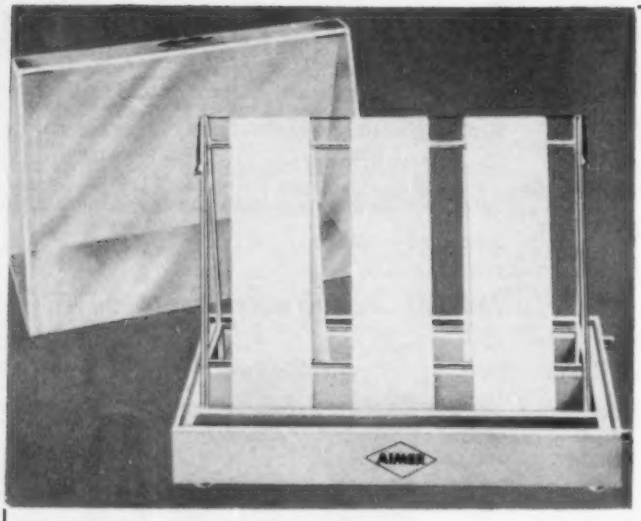

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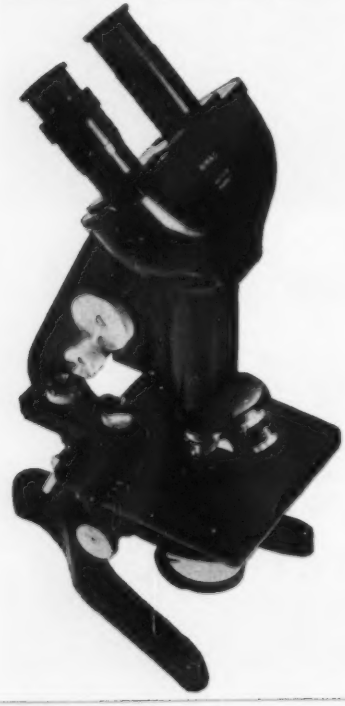

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EDITORIAL

Qualifications—Real and Bogus

ONE result of the scientific age we live in has been the increased frequency with which one sees names of people adorned with a string of letters. In addition to the long established degrees and diplomas we see new ones almost daily. To the uninitiated such titles may be impressive, and there appears to be an increasing use of them for commercial purposes. What may be called the 'classical' qualifications are mainly confined to professional people who do not advertise, so that the public tends to see more of other 'letters' which may or may not be worth anything.

Qualifications described by letters after a name may be placed in four groups. Firstly we have the degrees of recognized universities—bachelor, master and doctor—which usually take pride of place. Broadly speaking, these represent the most difficult of all paper examinations and are the most sought after. A few professional examinations may be stiffer than a degree, but appropriate degrees often give exemption for whole or a part of a professional qualification. Universities and certain chartered bodies confer their degrees or titles by virtue of a royal charter so that these titles emanate from the Crown and thus are really the only legal titles in this category.

Secondly we have various diplomas given by recognized colleges after periods of full time study for two or three years. These diplomas are usually more practical in outlook than degrees and do not have the academic status of the latter. They may be of greater importance than a degree for certain types of employment. Thus for a practical job in agriculture or horticulture an employer might value a diploma more than a degree.

In the third category come all those letters so frequently used by some people to indicate membership of societies—scientific, technical, artistic, literary, in fact covering almost all activities of a cultural nature. The common feature of these is that anyone can become a member by getting himself proposed and paying an annual subscription. Some of these organizations have obtained a royal charter and call their members 'fellows' so that there is a certain dignity in being described as a Fellow of the Royal Society of

———————. The initiated realize that such a description is not a qualification, but to the general public such impressive descriptions or 'letters' often imply a qualification.

These 'letters' carry no weight in government departments, learned societies or large firms, but they may have some commercial value with the general public or with small firms. On the whole they are harmless and if people like to add to their dignity by such devices there seems to be no good reason to interfere with their innocent pleasures. It is most unusual today for professionally qualified people to use letters in this way.

Our fourth category is the only one which may be a matter of concern. It has been known for unscrupulous persons to use degrees such as D.Sc. or membership of professional institutions such as the Royal College of Physicians or Veterinary Surgeons when they have no right to them, not even possessing a 'Failed Inter B.Sc.' as one gentleman (quite correctly) described himself. The latter group of fraudulently claimed qualifications is easy to detect because these professional institutions have a directory or register which can be consulted in most public libraries. The bogus holders of these 'letters' are caught out sooner or later. With university degrees the problem is very different. If a man describes himself as B.Sc. or Ph.D. it is very difficult to check his claim unless the university is known. Even then if the university is very large or obscure there may be some difficulty. It may be argued that this matter is of little importance because a fresh graduate inevitably gets his first job on his professor's recommendation, and thereafter is 'handed on' from one employer to the next. This may be true, but at least one case is known in this country where a man achieved a very high scientific appointment and duped persons at the highest level on the basis of high degrees which he did not possess. Detection only occurred through what may be described as non-academic activities.

It would not be practicable, or indeed worth while, to control the use of 'letters after the name', but there is a good case for preventing the fraudulent use of good qualifications. If a man falsely describes himself as L.R.C.P., the College would prosecute him, but who is to prosecute a man who falsely describes himself as B.Sc.?

The simplest solution to the problem would be the issue of a register of all graduates of British Universities. Even then this would only be effective if graduates always gave their university when using their degree. Such a volume giving the full name, degrees and subjects with dates, would be very useful. Of more specialized usefulness would be a 'Who's Who' in the various branches of learning, such as science, but this type of reference book has two grave disadvantages. It is not comprehensive, and the information is supplied by the entrants themselves. For a 'Who's Who' in science to be completely dependable, claimed qualifications would have to be checked with the records of the universities and professional bodies concerned.

CORRESPONDENCE

To The Editor,
Laboratory Practice.

DEAR SIR,—In the second of his articles on Complexometric Analysis (printed in your August issue) Mr. J. A. R. Genge gives, as Experiment 3 (p. 593), a back-titration method for nickel. While not doubting the validity of this method I must contradict the statement in the sentence preceding the paragraph giving details of Experiment 3:

> 'A direct titration is not possible in this case as the nickel-EDTA complex is formed slowly'.

I have been using, for several years, a method in which the ammoniacal solution of nickel is directly titrated with M/100 EDTA and which gives excellent reproducibility. Murexide is used as indicator, giving a sharp end-point from yellow to violet.

As Mr. Genge's article, giving working details, is presumably intended for readers unfamiliar with complexometry, I feel that they should be told that 'in this case a back-titration is unnecessary'.

I append four references which describe this direct method:

Flashka, H. (1952). Mikrochim Acta **39**, 38; **40**, 42.

Schwarzenbach, G. and Flashka, H. 'Komplexone. Titration mit Hilfe von Komplexonen . . .'

Pribil, R. (1952). 'Komplexometrie', Chemapol p. 23.

Schwarzenbach, G. 'Complexometric Titrations' (English Edition with revisions 1952) p. 79 Section 6. 19.

Yours faithfully,
J. HALL

51 *Cambridge Gardens*,
London, *W.*10

Fusion Research Programme

The Annual Report of the Atomic Energy Authority for 1959-60 stated that an experiment, called the Intermediate Current Stability Experiment, was being designed. The purpose was to study the stability of a toroidal or ring-shaped sheath of hot ionized gas carrying a large electrical current and subjected to applied magnetic fields which should keep the sheath stable.

The design studies, supported by experimental and theoretical work, have now shown that to construct this very large apparatus at this time is an undertaking which would take more effort and resources than the Authority consider they are justified in devoting to a single experiment in the present state of knowledge of plasma physics.

The Authority are not, therefore, now proceeding with the construction of I.C.S.E., but intend to broaden the fusion programme with a number of smaller but important research experiments, improved methods of diagnostic measurements, and the further development of the advanced techniques needed to produce high temperature plasmas.

British Laboratory Ware Association

A new class of membership—Associate Membership—has been approved by the British Laboratory Ware Association. Over 20 manufacturers and suppliers who have favourably considered such membership are being notified.

EXHIBITION LECTURES

RECENT ADVANCES IN LABORATORY TECHNIQUES: RHEOLOGY

by G. W. Scott Blair, M.A., D.Sc., F.R.I.C., F.Inst.P.

National Institute for Research in Dairying, The University, Reading

Introduction

Advances in laboratory techniques in any particular discipline are generally of three kinds. The first depends on extensions in the range of the subject matter treated by the discipline itself. Applications to new materials and to hitherto unexplored fields of study require new techniques. The second follows the developments of theory; for example, a new mathematical approach suggests new experiments. The third follows technical advances in instrumentation and in methods of recording measurements. We will consider some examples of each of these in turn in relation to rheology.

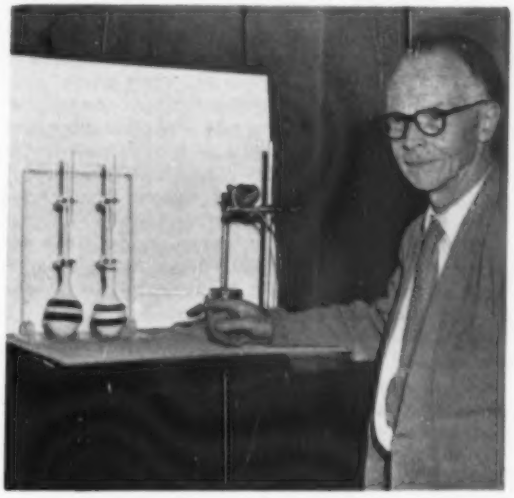
At the start, however, it should be pointed out that what is called 'new', within the first and second categories at least, is generally no more than a rapid growth of seeds sown long ago. For example, one of the earliest classical researches in rheology, that of Poiseuille, had as its aim the study of the flow of blood through the blood vessels; yet biorheology and the laboratory techniques which it requires would be generally considered to be quite recent developments.

Some 30 years ago, the late Prof. Wilder D. Bancroft gave a lecture at Cornell University to his graduate students (including the writer) entitled 'Ripening the Time', in which he pointed out that the research worker has two tasks: finding things out, which is not usually so very difficult, and 'ripening the time' for the useful application of his findings, the latter being by far the harder task.

Many text-books contain sentences of this kind: 'In 1885, X noticed that when substance A was heated (under certain conditions) a black residue was formed, which he discarded. In 1935, Y found, in this material, the basis for a highly useful group of plastics'. The ripening time is often about half a century.

The Widening Field of Rheology

Rheology, as an independent discipline, was conceived in about 1927 and had its birth at a Conference held in Washington (D.C.) in December, 1929. The writer had the privilege of presiding at one of the sessions of this first Conference. The term 'Rheology' was defined to mean 'the study of the deformation and flow of matter' and it was stressed that this would not include the flow of electric currents, heat, etc., only of gross matter. It has also been the custom, in practice, to restrict rheology to studies in which the properties of the matter investigated are under consideration, thus eliminating most of aero- and hydro-dynamics and the classical theory of elasticity which would otherwise fall within the definition.



Dr. G. W. Scott Blair.

In 1929, if we except the hardly germinated seeds already mentioned, rheology was mainly concerned with such substances as asphalts, pitch; ceramic materials, lime, cement; lubricants; paints, oils, varnish, lacquers and plastics; rubber. (This list follows the classification of Technical Abstracts in the earliest numbers of the Journal of Rheology, 1929-1930). The Proceedings of the Third International Congress on Rheology (Bad Oenhausen, 1958) dealt specifically also with these additional materials: mucoid sputum, protoplasm, blood, magnetite suspensions, fats, geological strata, metals, peat, bentonites, adhesives, soaps, doughs and a wide variety of high-polymers, unknown in 1929.

Such an expansion in the scope of the science (and of course this list is far from exhaustive) has required a considerable development in laboratory practice, notably because of the extended range of consistency covered and perhaps even more because, unlike the earlier materials, some of the newcomers are available only in very small quantities.

This lecture was delivered at the recent Laboratory Apparatus and Materials Exhibition under the chairmanship of Dr. G. I. Finch.

Theoretical Developments: Increasing Use of Tensor Notation

With the discovery of many new and some strange rheological phenomena, theory has had to be much extended. In the writer's opinion, there is still no single coherent body of rheological theory, but many new and interesting mathematical tools have, in recent years, either been introduced or at least their use has been very much developed; and it may well be that a final unification is not far off.

The scope of this lecture justifies only a brief mention of a few of these theoretical developments; yet mention there must be, because much instrumental development has come from these new lines of approach.

The most striking example is the wide extension of the use of tensors in rheology. In 1929 rheologists were almost exclusively concerned with unidirectional or uniplanar stresses; and usually with deformations only in the same directions as the applied forces. Thus capillary, concentric cylinder and falling sphere viscometers, or simple compression or extension devices for studying solids, generally sufficed. States of stress and strain were known to be given by second-rank tensors, but these and the fourth-rank 'combined' tensors were hardly used by rheologists working outside the classical Theory of Elasticity.

The pioneer work of Reiner (1943) introduced rheologists to the great potentialities of the use of tensors and led to their application by such workers as Oldroyd (1947, 1948) for complex rheological systems and Rivlin (1956) for the study of large deformations which fall outside the scope of classical theory.

The discovery and subsequent investigation, theoretical and experimental, of the so-called 'Weissenberg Effects' (to be discussed below) has high-lighted the importance of a three dimensional approach to rheological problems and hence to the usefulness of the tensor notation. On the experimental side, it has led to the development of Weissenberg's 'goniometric methods' (*see* Jobling and Roberts, 1958), i.e. 'the measurement of the distribution of stresses and strains within the flowing material at every instant in time and at every point in space, around the full solid angle of directions'. Some of these methods will be discussed later.

Measurements of Processes rather than of Properties

In a rather different field of theoretical development, we find a growing realization that the general rule of classical physics that properties must not be changed by the processes of their measurement can no more be applied in rheology than it can in quantum physics. Only in the simplest cases in rheology can we make *reproducible* measurements on a single sample. What we do is to make *replicable* measurements on a number of as nearly as possible identical samples. In some cases, the original conditions may be re-established by applying suitable counter-stresses: in others, including almost all biological systems, the process of testing alters the sample irreversibly.

Such tests are often purely empirical, but attempts have been made to develop a theory in terms of 'quasi-properties'. (*see* Scott Blair *et al.* (1947); Scott Blair and Caffyn (1948); Graham (1953)). The classical properties of a material such as its viscosity or elastic modulus, are expressed in terms of single quantities of invariant dimensional composition, e.g. 100 dynes/cm^2. Quasi-properties involve not only dimensional quantities, but also numerics which indicate the position of the material in a space of, normally two or three dimensions, within which the classical properties are represented by points.

Quasi-properties do not have tensorial invariance, and some physicists are inclined to say 'You can't do that sort of thing; or, if you do, your quasi-properties have no fundamental significance'. This question was recently discussed very fully at a meeting of the British Society of Rheology and it is hoped that the papers will be published in due course. The mathematical technique involved is the fractional differential or better, integral calculus. Whatever may be the final synthesis arising from these discussions, the idea of measuring processes rather than static properties has had its effect on laboratory practice.

A somewhat similar problem has arisen concerning the theoretical interpretation of Casson's equation. Many materials, such as enamels, inks, molten chocolate and blood, give rather unpromising looking flow-curves when shear-rate is plotted against stress for data from a capillary or concentric cylinder viscometer. Studying varnishes and printing inks, Casson (1959) has proposed an equation which involves a plot of the square roots of shear rate and of stress; and this has made it possible to classify many of these materials by means of two parameters representing the slope and position of a straight line. The treatment is by no means entirely empirical in the usual sense of the word. Yet the equation as it stands can only apply to data obtained from shearing in a single direction, because a reversal of the sign of the stress would introduce the square root of negative quantities into the descriptive parameter, which has no imaginary component in the first place. Here is another instance where we are studying a process of shear rather than an invariant property.

Sometimes it is possible to minimize the effects of testing on the properties of a material by arranging to disturb a continuously renewed sample. For measurements intended to follow progressively changing viscosity, the falling sphere viscometer suggests itself although it is difficult to ensure that a series of spheres will fall always in different places. Moreover, Mardles (1946) has pointed out that for certain materials which have some rigidity (greases), a falling sphere tends to decelerate because 'greater energy is required to displace the system at greater depths because of the rigidity of the system'.

To obviate these difficulties a viscometer has recently been described for structural liquids (Scott Blair and Oosthuizen, 1960) in which the rolling of a very small nylon sphere is timed down a sloping cylindrical tube,

which can be rotated through a small angle between runs, so as to ensure that the same material is never sheared twice. Except at very small angles of tilt, which are not convenient, quite a high proportion of the force on the sphere is needed, not to overcome viscous resistance but to accelerate the material around the sphere. Fortunately this inertia term is very easily allowed for.

Dynamic Testing

Finally, the development of the theory of sinusoidal straining has called for the development of many new rheological instruments. In static rheological theory, elastic deformations (other than those of high-elasticity) involve a storage of potential energy which is recovered when the stress is removed, whereas viscous flow involves a dissipation of energy as heat. In the sinusoidal straining of a complex material, part of the energy applied is stored and recovered during the cycle and part is dissipated as heat. What is observed is that the stress response curve gives a wave having the same frequency as the strain curve, but is out of phase with it by a measurable angle. The tangent of this angle gives the ratio of the two parts of a complex modulus which, by analogy with similar phenomena in electricity, are called 'real' and 'imaginary' (The latter means no more than that the so-called 'imaginary number', $\sqrt{-1}$ appears in the definition). This time, however, the two moduli represent quite different modes of behaviour, so no theoretical difficulty arises. The 'real' part of the complex modulus is a measure of the energy per unit volume stored during the cycle; and the 'imaginary' part, of that dissipated as heat.

With most materials, as the frequency is increased, the balance continually shifts as the sample behaves in a more and more elastic manner. With a few materials, the reverse is found to be the case. Whether we regard a material as solid or liquid will often depend on our time-scale. Glass rods, held horizontally and supported only at their ends, have been alleged to bend sufficiently over a period of 20 years or so, at room temperature, to make it possible to calculate their viscosity. Reiner (1960) prefaces his most recent book with a quotation from the book of Judges: 'The mountains flow before the Lord'. But, since 'a thousand years are but as a day in His sight', we generally regard rocks as solids and not as liquids. Rheological classification is thus arbitrarily dependent on our time-scale. In dynamic testing, we change the time-scale by altering the frequency.

Technical Advances in Instrumentation*

The changing of time scales, especially their reduction, is hardly possible without the introduction of electronics. Viscometers used to be timed, and often still are timed, with a stop watch. It is already some years since electrical recording was first introduced to follow falling spheres in opaque liquids. Today times and frequencies can be recorded to within a very small fraction of a second, and sometimes extreme precision is needed with respect to a length. To illustrate both these requirements we will consider more fully the Weissenberg Effects.

Priority in this connection is somewhat obscured by the secrecy requirements of the Second World War, during which much of the early work was done. Even before that time, however, it had been noticed that when certain complex materials were sheared in a concentric cylinder viscometer, the experiments were vitiated by the sample's climbing up the rotating cylinder. Such materials will, of course, also climb up a rotating vertical rod. This climbing, against the force of gravity, implies the existence of 'cross-stresses', as they are called, i.e. stresses at right-angles to the plane of shear. These stresses may be measured by shearing between two parallel plates, the lower of which is rotated, while the upper plate is sometimes perforated to hold a number of vertical stand-pipes at varying distances from the centre. Alternatively, the overall upward thrust can be measured without the stand-pipes. The apparatus is improved if one of the plates is replaced by a flat-angled cone. As the relative velocity increases with distance from the centre so also does the width of the gap, and in this way the rate of shear across the sample may be kept remarkably constant. As the cross-stress effect builds up from the periphery to the centre of the disc, a parabolic profile is obtained across the series of stand-pipes if these are used.

Such instruments may also be used for oscillatory straining. The upper plate is attached to a calibrated torsion bar and the frequency curve is determined electronically. The real and 'imaginary' components of the complex modulus may be evaluated in this way. As a straight viscometer, for liquids viscous enough to hold between the plate and the cone, the instrument has the great advantage that viscosity readings can be taken so quickly that there is no time for the shearing to cause any appreciable rise of temperature. The instrument,* invented by Prof. K. Weissenberg, is now known as the 'Rheogoniometer'. This is not just a new rheometer—it represents an entirely new outlook in rheology: the goniometric approach which Weissenberg has developed, inspired directly by the philosophy of Einstein.

Apart from the rheogoniometer, mention should be made of other cone-plate instruments† which do not measure cross-stresses. These are largely based on the work of McKennell (1954, 1956).

Recently, the Weissenberg effect has been found in an unlikely material: air. Reiner (1957) has shown that if a vertical cylinder, closed at the top, is rotated fast and then dipped into a very viscous oil, the oil does not wet the cylinder surface. On the contrary, air is pumped from outside the cylinder into the inside, provided that a tube is inserted to allow of its exit, Long ago, Maxwell predicted that thin air films would show elasticity but

*For an excellent summary of up-to-date rheological testing methods, the reader is referred to Oka (1960).

*Obtainable from Farol Instrument Co., Bognor Regis, Sussex.
†Obtainable from Ferranti Ltd., Hollinwood, Lancs.

supposed that this would be too small to measure because of the very short relaxation times. Following this phenomenon further, Popper and Reiner (1956, 1957) describe an all-metal centripetal air-pump. This consists of two circular metal plates, one stationary and the other rotating parallel to the first at a distance which can be very accurately adjusted. When this distance is reduced to about 0·02 mm. with the disc rotating at 10,000 r.p.m. air is drawn centripetally into the gap between the discs. (*See also* Reiner, 1960). In order to be sure that this effect is not an artifact, it is essential that the flatness and alignment of the plates should be extremely precise.

Goniometry in Dilatancy and Rupture

The opinion is sometimes expressed that the sole purpose of all but the most *ad hoc* rheology is to interpret observable phenomena in terms of molecular structures. Though such interpretations are often most valuable, they are by no means always essential, or even possible. For example, two samples of chemically identical sand, with spherical particles but having different size distributions, will show quite different stress-strain relations, with no corresponding differences at the atomic or molecular level. The tendency for many materials to stiffen on shearing used generally to be ascribed to dilatancy, the expansion associated with a change from close to open packing. Today it is known that frequently no such mechanism is involved and it is one of the most urgent problems of rheology to explain such phenomena. An excellent technique for these investigations is to put a layer of the material on to a sheet of rubber attached to four rigid grips, by which the strains in all directions can be controlled. The patterns produced in the materials, somewhat similar to the well-known phenomenon of 'crazing' of paints and soils, throws much light on their coarse structure and on their mode of failure under strain. (*See* Jobling and Roberts, 1958).

Biorheology

It will be noticed that quite a number of the materials discussed at the last International Congress were of biological origin, for which only very small samples are generally available. Apart from the rheogoniometer, few instruments are on the market for testing small samples of complex materials. Exceptions are the Rheogoniometer, the Techne filling capillary viscometer* and a rather similar emptying capillary consistometer† recommended for measuring the consistency of mucus from the uterine cervix (*see* Scott Blair and Glover, 1956).

The designing of micro-apparatus for biorheological purposes by individual rheologists goes back much further, however. Seifriz (1930) describes a number of instruments, including one of his own design, in which the movements, induced by an electro-magnet, of a tiny particle of metal, embedded in protoplasm, may be observed under the microscope and the rheological properties of the protoplasm determined. In a later paper (Seifriz, 1946) he describes how 'a delicate glass needle suspended in a horizontal position on the end of a freely-hanging strand of myxomycete protoplasm, swings alternately to the right and to the left through an arc of about 40° when the protoplasm is in a state of flow. The swing of the needle is the result of the twisting of the living thread brought about by the streaming of the protoplasm'.

For the study of bronchial mucus, Elmes and White (1954) used a syringe, measuring the rate of sinking of a weighted plunger, perforated with a number of short capillaries. This is really a modification of the well-known Gardner Mobilometer, adapted for use for very small samples.

The Hess viscometer* compares directly the rate of flow of a small sample of blood with that of water, in parallel capillary tubes under the same (unmeasured) pressure. For a study of variations of viscosity with rate of shear, a more convenient form of capillary viscometer has recently been proposed (Copley *et al.* 1960). A micro apparatus for measuring the rate of coagulation of about 1 ml. of blood is described by Scott Blair and Burnett (1959).

On the borderlines of rheology, much valuable work is being done on the birefringence of biological materials. A convenient apparatus for measuring this, as well as the viscosity, is described by Glover and Suffolk (1957).

Conclusions

It may, perhaps, be felt that the development of laboratory techniques in rheology has been somewhat piecemeal. By comparison with most other branches of physics, rheology still suffers from a somewhat incomplete theoretical structure. Until a unifying system is established, improvements in laboratory technique will tend to follow sporadic requirements and to depend mainly on technical advances in instrumentation.

The nearest approach to a unifying principle so far is to be found in Weissenberg's goniometric methods which link rheology with fundamental physical theory and especially with the philosophy of relativity. Some day, however, the tensorial approach will also have to form a synthesis with the non-tensorial concepts which most readily describe the processes rather than properties with which rheologists are, unfortunately, generally obliged to deal.

*Manufactured by E. F. Buchi, Bern, Switzerland.

ACKNOWLEDGMENTS.—*My best thanks are due to Prof. K. Weissenberg for most helpful discussions and to Mr. H. A. Johns and the Gillette Company for the loan of apparatus for demonstrations.*

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Copley, A. L. (1960). Scott Blair, G. W., Glover, F. A. and Thorley, R. S., Kolloidzschr., **168**, 101.

(*Concluded on page* 785.)

*Obtainable from Techne Ltd., Duxford, Cambs.
†Obtainable from Messrs. Arnold & Son, Wigmore Street, London, W.1.

AN INTRODUCTION TO SAFETY IN THE MICROBIOLOGICAL LABORATORY

by H. M. Darlow, B.A. (Cantab.), M.R.C.S., Surg. Cdr. R.N. (retd.)

Microbiological Research Establishment, Porton, Nr. Salisbury, Wilts.

THOUGH the modes of transmission of microbial diseases are familiar, the occurrence of infection among laboratory workers shows that the microbiologist still has something to learn about the special hazards attendant upon the handling of infective organisms under the specific conditions of both standard laboratory practices and the more elaborate procedures involved in modern research methods. It is not always easy to prevent familiarity from breeding a certain degree of contempt, and absorption with a research problem can only too frequently tempt the microbiologist to take avoidable risks, or even blind him to obvious hazards. Furthermore the field of microbiology of recent years has been greatly augmented by scientists without a medical or veterinary training, and not infrequently lacking that inbred cross-infection consciousness which should be engendered by clinical experience.

Though a great deal of work has been done on the transmission and prevention of laboratory infection, there has been a lamentable paucity of published material on the subject in this country, and, in the author's experience, a commensurate lack of appreciation of the problems involved. The subject covers a wide field, and cannot readily be condensed, but Morris (1960) of this Establishment in a well documented paper has reviewed much of the work on laboratory hazards together with methods of investigating and preventing them. He very rightly emphasizes the importance of the aerosol hazard, which is probably the commonest and most insidious, and quotes references to the relatively high infectivity of inhaled aerosols, including those of organisms that do not naturally gain entry to the tissues via the respiratory tract, but can do so under certain conditions.

Generally speaking, infective organisms gain entry to the tissues by inoculation through mucosae or broken skin, by ingestion and, thirdly, by the inhalation of infected particles.

Aerosols can be generated in the course of the commonest and simplest of bench techniques, involving turbulence at the interface between a liquid suspension of organisms and the atmosphere. The process is not necessarily accompanied by macroscopic splashes or frothing, and, therefore, often goes undetected. Once air-borne, the droplets so produced evaporate extremely rapidly, leaving a solid droplet nucleus varying in size according to the concentration of the suspension and quantity of dissolved solids. The fate of the resultant particles (or for that matter, those which may be produced by the mechanical comminution of dried crusts on bottle caps, etc.) will depend upon their size; the smaller the particle, the longer will it remain aloft and the further will it be dispersed by diffusion and air currents.

Surg. Cdr. H. M. Darlow delivers his lecture. Chairman: Prof. A. A. Miles.

Provided that the organisms remain viable without loss of virulence, then the longer the aerosol persists, the greater will be the chances that an infective dose will be inhaled. Particles of 4μ or less can be inhaled into and retained in the pulmonary alveoli, where some organisms are capable of producing a far more fulminating type of infection at a lower dose rate than when ingested or when inoculated sub-cutaneously or conjunctivally. Naturally occurring examples of this are pulmonary anthrax and pneumonic plague.

Though the mechanism of the aerosol hazard has been investigated by tracer methods, the actual detection of air-borne pathogens in practice is by no means so simple. The efficiency of air sampling techniques varies considerably with existing circumstances, and many pathogens are highly sensitive to the traumata involved in particle collection. In all methods there is inevitable delay in the culture and identification of the organism, a delay which may well jeopardize the efficacy of subsequent corrective measures. When this delay factor is added to the high potential infectivity and inherent tendency for aerosols to be generated during simple

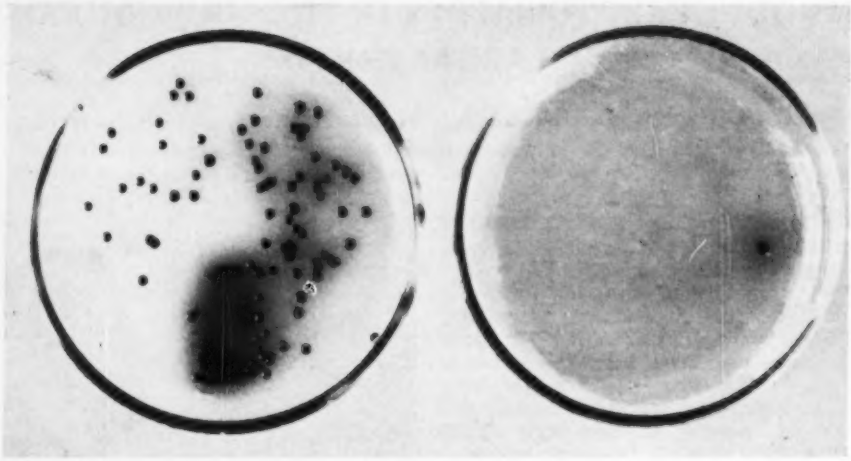

Fig. 1.

bench techniques, it becomes clear that new procedures must be adopted to protect the health of the laboratory worker and his associates.

The foregoing indictment of aerosols consists of a mixture of fact, circumstantial evidence and logic, from which it might be argued that the aerosolization of dilute suspensions could be more dangerous than that of concentrated suspensions, because the former would tend to give rise to smaller and hence more persistent and infective particles than the latter. For this there is some evidence.

An example from the author's own experience adds weight to the above assertions. During the past nine years a number of laboratory accidents involving pathogens have been investigated in several departments and of these 120 have been considered worthy of detailed description in a log book kept for the purpose. The accidents involved major spills, wounds and ingestion of toxic material. In all cases the worker was aware that something abnormal had occurred, and reported the fact immediately. Hence it was possible to take sufficiently prompt and effective action to prevent the occurrence of a single case of laboratory infection. On the other hand, between 20 and 30 cases of laboratory infection have also been investigated during the same period. Some of these, admittedly, were subclinical in that they involved a sustained rise in agglutinin titres, accompanied by the development of positive intra-cutaneous tests and indefinite symptomatology. Others, however, were of a more serious nature and required antibiotic therapy. None was preceded by a known accident. The one common factor (with a single exception) was that all the individuals concerned had been involved in some way with serial dilution of bacterial suspensions, and subsequent plating out by means of pipetting. The exceptional case was one of pseudo-tuberculosis in a man, who unwisely handled infected animals with his bare hands.

It is probable that many of the accidents and all the infections could have been avoided, if the necessary (and available) precautions had been taken, but there exists an unfortunate gulf between what is needed and what is convenient, across which many are not prepared to take the trouble to jump. Safety precautions, once properly understood, are not as troublesome as might be expected, though misunderstanding and misapplication can readily lead to a situation in which the worker is lulled into a false sense of security with unfortunate results.

Many of the principles concerned in the protection of the laboratory worker from the infective hazards of his work are equally applicable to the handling of radio-isotopes and also to the prevention of contamination of cultures and sterile materials. However, it is not the intention to elaborate on technique in this essay, but rather to draw the reader's attention to the existence of hazards, and to the review quoted above.

The mechanism and prevention of specific hazards will be dealt with at length in subsequent, more technical, papers. However, it would be a pity to let this opportunity pass without producing an entertaining example to whet the reader's appetite.

A common laboratory accident is the dropping of petri dishes on to the floor. It might well be supposed that the hazard was minimal by virtue of the semi-solid nature of agar and bacterial colonies growing thereon. The shearing action produced by the fracture of glass and medium, however, is capable of disrupting the colonies and generating a considerable aerosol. This is amply illustrated by the following simple experiment, in which a pile of ten glass agar plates, each bearing approximately 50 24-hour colonies of *Serratia marcescens*, was elbowed off the bench on to a lino-covered floor three feet below. The resultant aerosol was detected by means of a slit sampler placed close to the

(*Concluded on page* 785)

CLINICAL BIOCHEMISTRY

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PART III

Enzyme Studies

Alkaline Phosphatase.—A chromogenic substrate for phosphatase was mentioned in Part II—*p*-nitrophenyl phosphate—which is only very slightly coloured, while its hydrolysis product, free *p*-nitrophenol, is intensely yellow in alkaline solution. Another much-used chromogenic substrate is phenolphthalein phosphate. This is also colourless, even in alkaline solution, whereas the hydrolysed phenolphthalein is intensely red-coloured (King, 1942). This substrate can be incorporated into a bacterial medium and used to reveal the presence of the enzyme in the bacteria, some bacteria being phosphatase producers and others apparently devoid of it (Fig. 20, Bray and King, 1942) Phenolphthalein phosphate has also been used for estimating the phosphatase in milk and in blood plasma.

There is an accumulation of alkaline phosphatase in the blood plasma in obstructive jaundice, as well as in generalized bone disease. For many years opinions have differed as to whether these two alkaline phosphatases were the same, or whether that associated with generalized bone disease, and derived from the osteoblasts of the bone, is different from that found in large amounts in the blood of patients with liver disease. Michaelis constants (Km) on the crude blood serum from Paget's disease and from obstructive jaundice, by the naphthol-phosphate method with spectrofluorimetric estimations, gave sufficiently similar results to

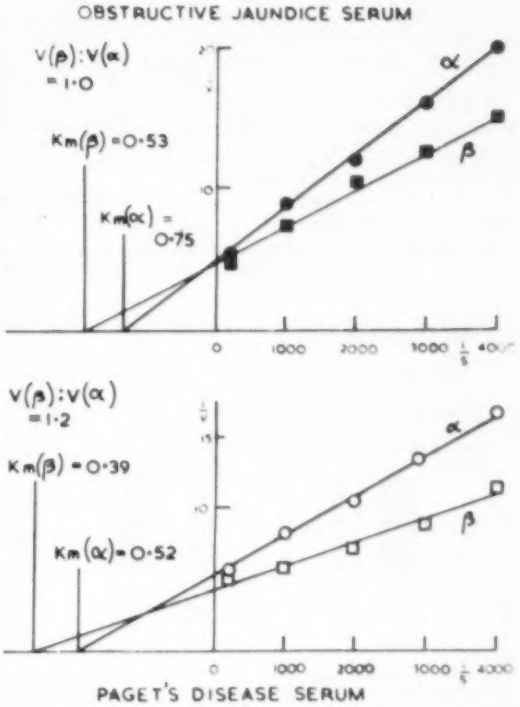


Fig. 21. Michaelis constants of the alkaline phosphatases in blood serum from Paget's disease and obstructive jaundice. See text.

Fig. 20. Organisms grown on medium containing phenolphthalein phosphate. The clostridium welchii (top) contain phosphatase. The sporogenes (middle) contain no phosphatase. The septique (bottom) contain a little phosphatase.

make it improbable that the enzymes in the two diseases were any other than the same (Fig. 21, Moss, 1960). When partially-purified enzyme, isolated by cutting out that section of the starch-gel strip which contained the phosphatase, was used for the determination of Michaelis constants, identical values for Km for bone-disease phosphatase on the one hand and jaundice phosphatase on the other were obtained. (Fig. 22, Moss and Anagnostou, 1960).

Acid Phosphatase.—An interesting chemical reaction, or set of reactions, used to demonstrate the presence of phosphatase in tissues is shown in Fig. 23. In addition to the phosphatase of bone, active at an alkaline pH, there is an extremely active phosphatase in the prostate gland, which is active at a pH of 5. The very high concentration of this enzyme in prostatic tissue can be

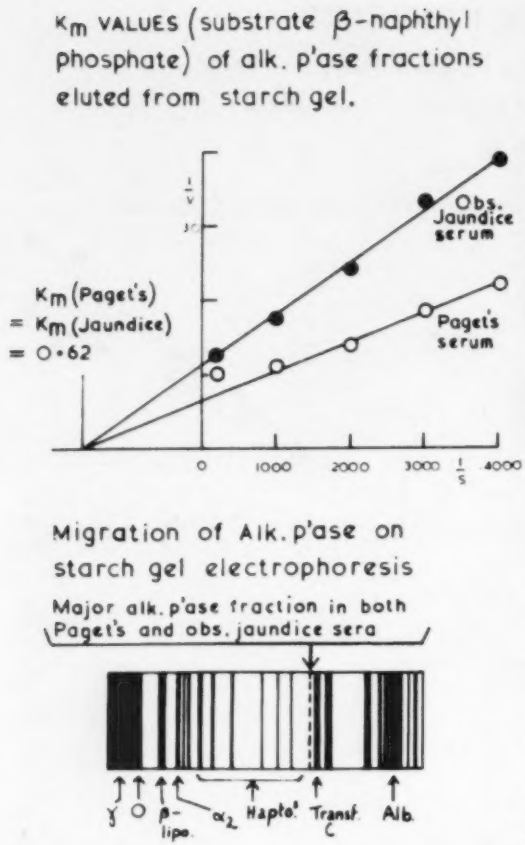


Fig. 22. Michaelis constants for the electrophoretically separated alkaline phosphatase from blood plasma of patients suffering from bone disease and from obstructive jaundice. See text.

shown by incubating a histological slide of the tissue in a solution of the soluble lead salt of glycerophosphate. The inorganic phosphate precipitates as the highly insoluble lead phosphate, as fast as it is hydrolysed from its ester combination with glycerol. After a suitable time, the soluble lead glycerophosphate can be washed away with water, leaving behind the insoluble lead phosphate. By then immersing the slide in hydrogen sulphide water, the lead is made visible by the formation of lead sulphide, which is even more insoluble than lead phosphate. The black stains so obtained in the histological section reveal the presence of the enzyme in the actual cells which contain it, and give a good idea of how much of it there is, according to the density of the lead sulphide precipitate.

This acid phosphatase is of great importance in the diagnosis of carcinoma of the prostate, and in following the success of its treatment. In this condition the enzyme leaks out into the blood plasma, and may be

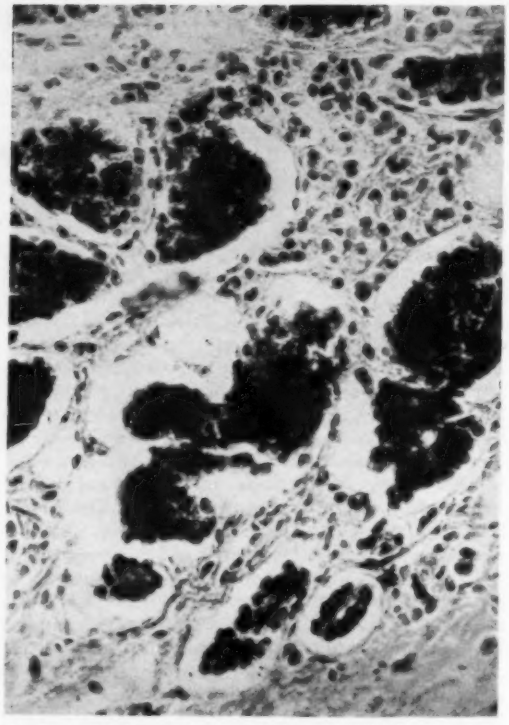


Fig. 23. Acid phosphatase in the prostate gland, stained by means of lead glycerophosphate.

there in very high concentration. Successful treatment of the carcinoma, particularly when there are extensive secondaries in the bones, usually results on administration of oestrogens such as stilboestrol and dienoestrol. Not only is the growth of the cancer controlled, but the clinical condition of the patient greatly improves, and the acid phosphatase of his blood plasma returns to normal levels. Failure of the treatment is marked by an elevation of the plasma acid phosphatase. Fig. 24 shows such a case. On treatment with dienoestrol this man's condition greatly improved, and his acid phosphatase came down within normal limits; but it began to rise again after a little over two years, and this rise was a forecast of an unfortunate deterioration of his clinical condition which occurred somewhat later. Change of his therapy from dienoestrol to stilboestrol almost immediately improved his condition and his acid phosphatase also came again into the normal range.

Glycolytic Enzymes.—Many years ago Warburg, the distinguished German physiologist, found a high concentration of glycolytic enzymes in cancer tissue. The initial steps of glycolysis involve the formation of glucose-1-phosphate from glycogen, the transfer of the phosphate from the first to the sixth position of the molecule under the action of the enzyme mutase, and

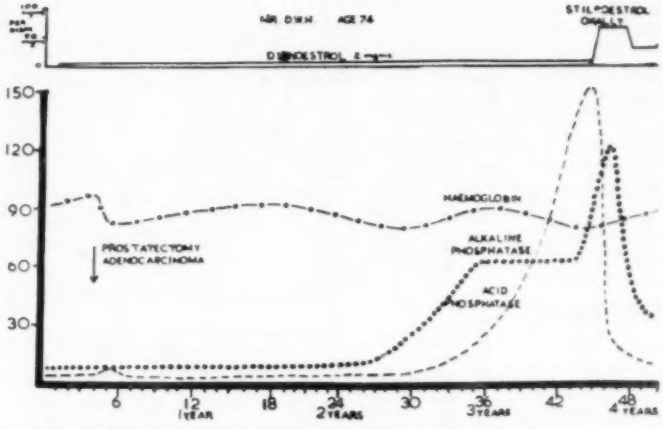
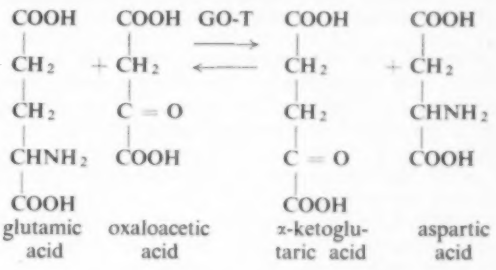


Fig. 24. Acid and alkaline phosphatases in the blood serum of a man treated with oestrogens for carcinoma of the prostate. (Wray, 1956). See text.

then the isomerization of the glucose-6-phosphate to fructose-6-phosphate, brought about by the enzyme isomerase. Another phosphate is then added to form glucose-1:6-diphosphate, and this breaks in two under the action of aldolase to form a molecule each of glyceraldehyde phosphate and dihydroxyacetone phosphate. The glycolytic enzymes leak out from the cancerous tissue into the blood, and as in the case of prostatic cancer so their presence in abnormal amounts is diagnostic of other forms of cancer, such as carcinoma of the breast. On successful treatment of this, too, not only is the spread of the cancerous growth controlled, but the clinical condition of the patient improves, and the enzymes return to within normal limits. Their estimation then is of use both for diagnosis and as a test of the effectiveness of therapy. (Fig. 25, Jegatheesan and Joplin, 1960).

Transaminases.—Amino acids are formed by transamination reactions, in which the amino group of glutamic acids is transferred to a keto acid, the keto group being accepted by the glutamic acid residue. Such a reaction is shown below.



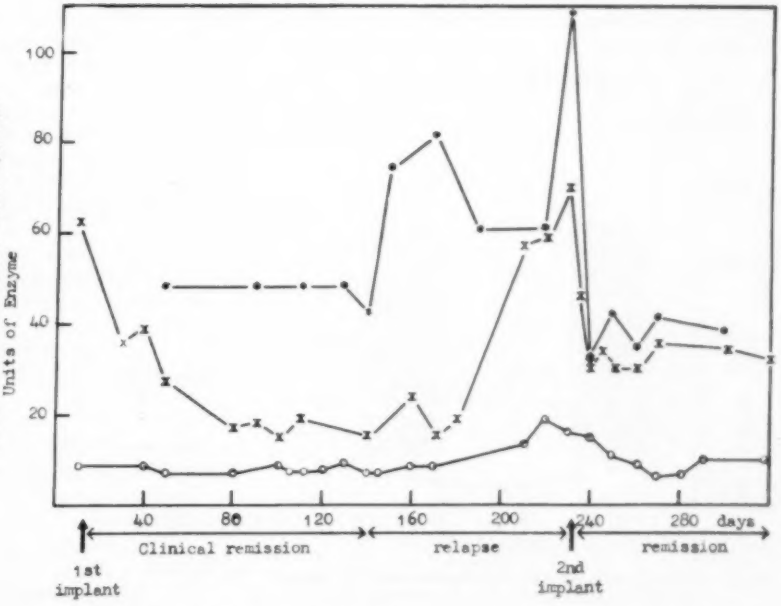


Fig. 25. Glycolytic enzymes in the blood plasma of a patient suffering from cancer of the breast, treated by ablation of the pituitary gland with a radioactive yttrium. Phosphoglucomutase (top), normal range 19 to 84 units, mean 46. Phosphohexose-isomerase (middle), normal range 8 to 40 units, mean 20. Aldolase (bottom), normal 2 to 9·6 units, average 5·8. On successful treatment, the plasma glycolytic enzymes dropped to normal levels; on recurrence of growth of the cancer after several months enzymes rise again; but on repeated successful treatment they again fall to within normal limits.

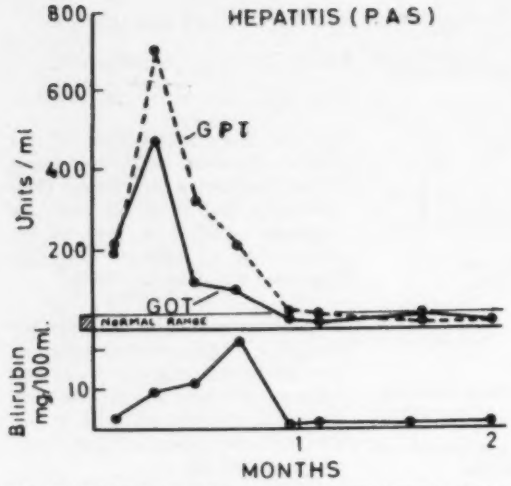


Fig. 26. Glutamic pyruvic transaminase and glutamic oxaloacetic transaminase in the blood plasma in a case of hepatitis.

The enzyme glutamic oxaloacetic transaminase accomplishes such a reaction with oxaloacetic acid. This enzyme is commonly referred to as GO-T. If pyruvic acid is substituted for oxaloacetic acid, then alanine is formed instead of aspartic acid; and the enzyme here is called glutamic pyruvic transaminase, GP-T. Both enzymes can be estimated by the dinitrophenyl hydrazine method for keto acids, or by the lactic dehydrogenase enzyme reaction from pyruvic to lactic acid, using the reduced form of disphosphopyridine nucleotide, DPNH. This has a strong absorption at 340 mμ., whereas the oxidized form DPN does not absorb at that wavelength.

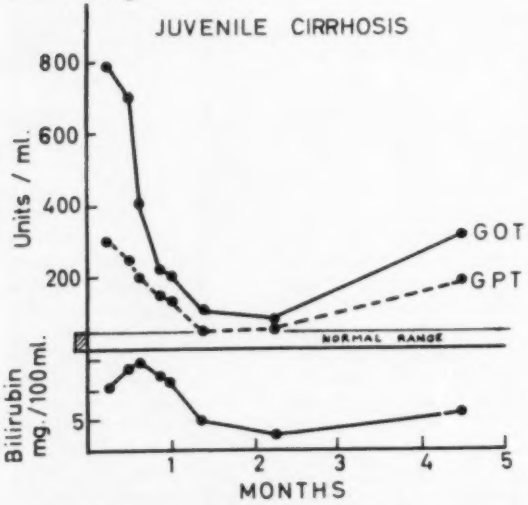


Fig. 27. Glutamic pyruvic transaminase and glutamic oxaloacetic transaminase in juvenile cirrhosis.

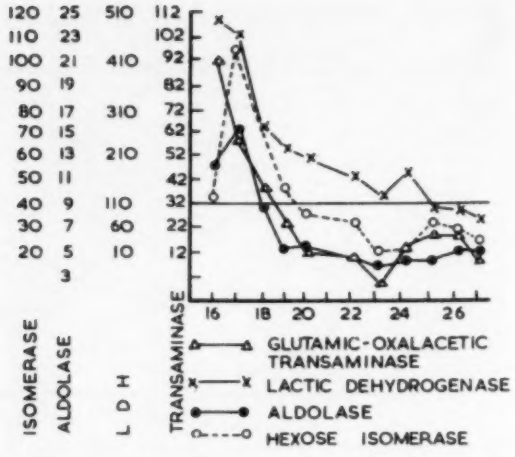

120 110 100 90 80 70 60 50 40 30 20
25 23 21 19 17 15 13 11 9 7 5 3
510 410 310 210 110 60 10
ISOMERASE
ALDOLASE
L D H
112 102 92 82 72 62 52 42 32 22 12
16 18 20 22 24 26
TRANSAMINASE
GLUTAMIC-OXALACETIC TRANSAMINASE
LACTIC DEHYDROGENASE
ALDOLASE
HEXOSE ISOMERASE

Fig. 28. Plasma enzyme levels in myocardial infarction. Fifty-five year old man. Transaminase and aldolase normal on third day after infarction, hexoseisomerase normal on fourth day and lactic dehydrogenase normal only after ninth day (White, 1956).

Both the transaminases are increased in liver disease. In hepatitis, the GP-T is higher than the GO-T (Fig. 26); whereas in juvenile cirrhosis the GO-T is higher than the GP-T (Fig. 27). Transaminase estimations are equally useful in the diagnosis of myocardial infarction. The glutamic oxaloacetic transaminase is present in high activity in cardiac muscle, the most actively working and actively metabolizing muscle of the body. Lactic dehydrogenase, aldolase, and isomerase are also present in heart muscle. In myocardial infarction a small clot of blood obstructs one of the blood vessels of the cardiac muscle; this results in necrosis of the adjacent areas of muscle which are now denied their blood supply; the enzymes leak out into the blood and abnormally high levels of them can be determined, and are an important adjunct to the investigation and diagnosis of this condition. If the patient recovers the levels of the enzymes return to normal (Fig. 28).

Galactosaemia.—An interesting metabolic pathway is that by which galactose is transformed into glucose. The reactions are illustrated below:

1. Galactose + ATP $\xrightarrow{\text{galactokinase}}$ Gal-1-Phosphate + ADP

2. Gal-1-P + UDPG $\rightleftharpoons$ UDPGal + G-1-P
(catalysed by phosphogalactose uridyl transferase)

3. UDPGal $\rightleftharpoons$ UDPG

4. UDPG + PP $\rightleftharpoons$ UTP + G-1-P
UDPG pyrophosphorylase

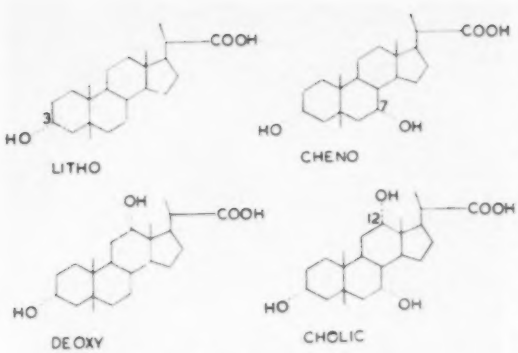


Fig. 29. Formulae of bile acids.

5. G-1-P ⟶ G-6-P ⟶ glycolysis cycle
(Gal-1-P = galactose-1-phosphate; G-1-P = glucose-1-phosphate)

In the clinical condition of galactosaemia, which may be a very serious disease in children particularly, there is a block at the uridyl transferase stage, with a consequence that the galactose accumulates in the blood since it is not metabolized. In infants the condition may be rapidly fatal, unless milk feeding is discontinued, the lactose in milk being the source of galactose. If galactosaemia persists, cataracts of the eye appear, and the child becomes mentally retarded.

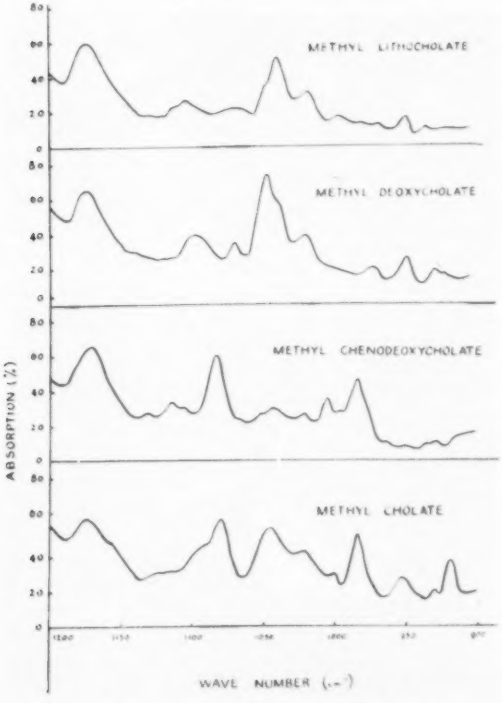


Fig. 30. Infra-red spectrum of bile acids.

Infra-Red Spectrophotometry

This important technique can be mentioned only briefly. Some substances absorb strongly in the infra-red, where their spectra are characteristic. Such substances are, for instance, the carcinogens which produce cancer, and the cholic acids found in bile. They are readily identified by their typical infra-red absorptions, and their individual spectra are called their 'finger prints'. Fig. 29 and Fig. 30 show the formulae of some bile acids and their infra-red spectra.

Isotopes

The use of isotope-labelled substances has revolutionized the study of intermediate metabolism. The pathways of metabolism and the fate of substances can now be followed in the body in a way not previously possible. But not only has their use led to a much better understanding of the chemical processes taking place in animals and other living organisms, they can also be used to measure the abnormalities which occur as the result of disease or, in fact, in any departure from the normal state. A simple illustration is seen in the measurement of the body compartments. The total body water can easily be measured by labelling part of it with tritium, which distributes itself throughout the water of the whole body. The extra-cellular fluid, that is the fluid not contained in the cells of the body but lying between them and in the pools of non-cellular fluid such as the blood plasma and the cerebrospinal fluid, can be measured with bromine 83, which distributes itself throughout the extra-cellular spaces without penetrating into the cells. The difference between these two gives, of course, the intra-cellular space. The fat of the body can be estimated with radioactive krypton, one of the inert gases, which is soluble in fat and relatively insoluble in water. In Fig. 31 these body compartments are shown diagrammatically for a healthy person and for an obese one.

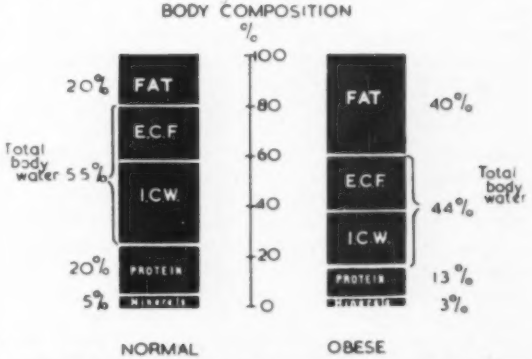


Fig. 31. Body compartments determined by means of tritium for total body water, radioactive bromine for extra-cellular fluid, intra-cellular fluid by difference, and fat by radioactive krypton. Left, lean person; right, obese person.

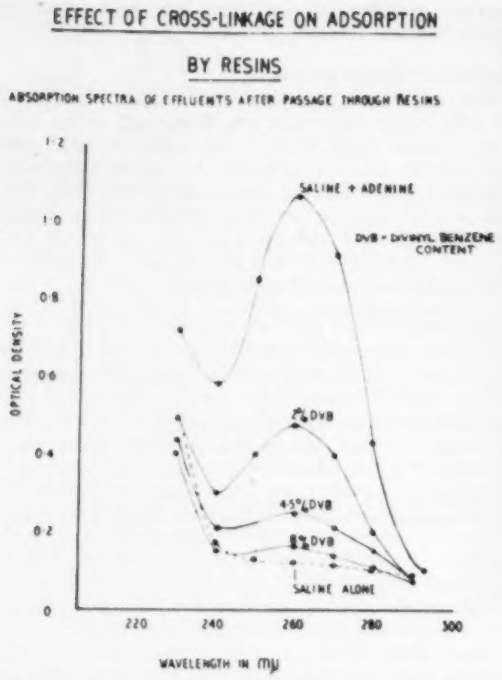


Fig. 32. Effect of cross-linkage on adsorption by resins of a purine dialysed from the blood by the artificial kidney. See text.

Fig. 33. Cardiac catheter passed through an arm vein into the heart. X-ray film.

Fig. 34. Tube passed through the mouth and stomach into the lower intestine. X-ray film.

Ion Exchange Resins

These materials have had a wide application in biological studies. It is possible with them to control the amounts of different electrolytes entering the body. The ingestion of an ion-exchange resin which will absorb potassium, for instance, will cause all of that ion to be tightly bound in the intestine, so that none can be absorbed into the body. Many useful physiological studies have been made in this way, which have led to a much better understanding of the metabolism of inorganic substances, of the passage of ions across the membranes of the body, of their excretion by the kidney, and of the importance in the maintenance of osmosis, acid-base balance and the proper nutritional state of the organism. They have also been used in the treatment of disease, when it may be necessary to control the amount of some inorganic ion getting into the body. Still another example of their use is in the isolation of substances of biological interest which are present in very small amounts in very large volumes. In the terminal stages of kidney disease, toxic substances are thought to accumulate in the blood, but it has never been possible to discover what these are. In the treatment of this condition with the artificial kidney, the blood is dialysed against large volumes of water, in order to rid it of these toxic substances. They are present in the very large volume of bath water in

extremely small concentrations. But by the use of cross-linked resins it is possible to isolate substances from such large volumes of liquid even though they are present at a very low concentration. Fig. 32 shows how the combination of adenine, a purine metabolite, is affected by the extent of cross-linking in an ion exchange resin. The top curve shows the absorption spectrum of a weak adenine solution, the bottom curve that of salt solution alone. The progressive effectiveness of the resin with increasing cross-linkage is shown by the fact that the optical density due to adenine decreases until it is almost absent, when the resin has 8 per cent divinyl as cross linkages.

Sampling

In the early days of clinical biochemistry, large amounts of blood and other body fluids were required for accurate chemical analysis. With the development of micro methods, the amounts of blood required have become progressively less. Nowadays most analyses in hospital laboratories are carried out on a few microlitres of blood, whereas two or three score years ago millilitres were required. But not only has sampling been reduced in amount, it is now possible to sample intimately into parts of the body which a few years ago would have been thought quite inaccessible. Figs. 33 and 34 show a cardiac catheter passed from an arm vein into the inferior ulna cava and so into the heart, from which blood can be directly drawn, and a tube passed far into the intestine.

SUMMARY

The progress of clinical biochemistry, in terms of some of its recent advances, has been reviewed. Mention has been made of improvements and innovations in inorganic and organic analyses, of new instruments such as the flame photometer, the spectro fluorimeter, the Autoanalyser and of new techniques such as chromatography, electrophoresis, enzyme determinations, infra-red absorption, and ion exchange resins.

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An Introduction to Safety in the Microbiological Laboratory

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point of impact, and a photograph (Fig. 1) of the sample plate (representing the contents of one cubic foot of air—sampled in one minute) appears on the left of the figure. On the right of the photograph a sample is shown taken after the fall of 20 similarly inoculated plastic plates, which do not fragment.

Although this accident should never occur, it inevitably does so, and the degree of hazard involved is greater than expected, though the adoption of plastic plates is clearly a step in the right direction. It exemplifies an accident, a hazard, a means of investigation and one possible remedy.

It has been said of late that, as hygienic conditions continue to improve, the human race will lose much of its resistance to microbial infection: in other words we are becoming hot-house plants, and hence must suppress our desire to throw stones. What is most important is that we live in an age in which the public demands safety in many spheres of living. As custodians of some of the more unpleasant causes of death, microbiologists cannot afford to remain aloof.

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Dr. G. Jones

The Royal Society announces that Dr. G. Jones, of the Rowett Research Institute, Bucksburn, Aberdeen, has been appointed to hold the Sophie Fricke Royal Society Research Fellowship in the Rockefeller Institute for the academic year 1960-1961. Dr. Jones will be working on the fractionation and characterization of leaf proteins.

THE LABORATORY EVALUATION OF GANGLION BLOCKING AGENTS

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PART III

Inhibition of Salivary Secretion

The use of ganglion blocking drugs in the treatment of hypertension is associated with the blockade of parasympathetic as well as sympathetic ganglia producing among other side-effects a reduction in the secretion of saliva.

Cushny in 1904[69] described a method for comparing the effects of a number of atropine derivatives on pilocarpine-induced salivary secretion, using a salivary fistula and collecting the saliva produced on cotton wool. His experiments were carried out on unanaesthetized dogs. Issekutz[70] used rabbits anaesthetized with urethane and collected the saliva in a small dish.

In 1934 Secker[71] used cats anaesthetized by intraperitoneal injection of sodium barbitone. Drugs were administered by means of a cannula inserted into the external jugular vein and blood pressure recordings were taken from the carotid artery on the same side. Saliva was collected from a glass capillary cannula inserted into Wharton's duct on one side. The lingual nerve on the same side was tied and cut near the exit of the chorda tympani and secretion excited by electrical stimulation or by intravenous injection of pilocarpine nitrate. The flow of saliva was recorded on a smoked drum surface by means of a Condon's drop recorder.

In 1945 Bülbring and Dawes[72] described a method of measuring salivary secretion, using cats anaesthetized by pentobarbitone or chloralose. A cannula was inserted into Wharton's duct and connected to a bottle containing tap water. Salivary secretion induced by intravenous infusion of pilocarpine or carbaminoyl choline displaced tap water from the bottle, and the amount displaced was recorded on a smoked drum surface by means of a Gaddum-Kwiatkowski[73] drop timer. A record of the amount of saliva produced was made and the effect upon this of drugs inhibiting salivary secretion noted.

Mason and Wien in 1955[15] used a similar method, recording the salivary flow from Wharton's duct induced by electrical stimulation of the combined chorda tympani nerves. These workers used square wave stimuli of 0.4 msec. duration at a rate of five per second. By this means it was shown that ganglion blocking agents inhibited the flow of saliva. Repeated subcutaneous injections of ganglion blocking agents produced a supersensitivity to adrenaline in the submaxillary gland and the nictitating membrane.

The Estimation of Mydriatic Activity in Mice

This method is based upon blockade of transmission through the ciliary ganglion by parasympathetic ganglion blocking agents. The method most commonly employed was described by Pulewka in 1932[74] and has since been used and modified by several workers.[75-79]

The method employed groups of five mice of both sexes, preferably inbred from laboratory stock. The weight of each mouse was approximately 16 g., as larger mice tend to be less sensitive. Each mouse was placed in a glass jar upon a white background illuminated by a fluorescent light shining approximately four feet above it. This ensures uniform illumination. The jars arranged in groups of five, were covered by wire mesh and the animals left at least half an hour before commencement of the experiment. It was originally suggested by Pulewka[74] that mice of one sex only should be used, but this is not now deemed necessary. The only other apparatus required is a binocular microscope magnifying about ten times and fitted with a scale in the eye-piece which is used to measure the pupil diameter. Fitted to the microscope is a light which shines into the eye-piece.

After initial readings had been taken, the drugs under investigation were injected intraperitoneally and after a period of ten minutes the diameters of the pupils were measured. Subsequent injections of the drugs were made at ten minute intervals and the results were calculated using statistical methods.

Ing, Dawes and Wajda[75] used this method to test for mydriatic activity in synthetic atropine-like compounds. Wien and Mason[45] also used it to test for parasympathetic ganglion blocking activity in a series of ganglion blocking agents.

Edge (1953)[76] also used this method to assay ganglion blocking drugs and confirmed the findings of Ing and his colleagues (1945)[75], and those of Wien and Mason (1951)[45] that the hexamethonium log dose-response curve was unlike that of atropine sulphate. However the method of assay was deemed valid as the curvatures of the two dose response curves were parallel. The reason for this difference may be a differing mode of action. Mohanty (1955)[79] showed that tolerance to the mydriatic activity of hexamethonium could develop and this was confirmed by Blackman *et al.*[78] However it was also shown that tolerance to hexamethonium did not develop provided there was an interval between doses of several days.

Estimation of ganglion blocking activity using this technique offers several practical disadvantages. For example, maximum mydriasis may not occur in every animal at the same time, but there are also disadvantages to the use of the method from a theoretical point of view. Mydriasis can be produced by several distinct mechanisms, and the activity of a ganglion blocking compound on the ciliary ganglion could possibly be opposed by an action on the superior cervical ganglion. Thus the experiment is mainly of value as a means of readily identifying those compounds suspected of having ganglion blocking activity which can be confirmed by other methods.

A modification of Pulewka's method[74] to differentiate between drugs acting on ganglia and those which in addition act on post-ganglionic parasympathetic sites has been made by Gyermek.[80] The method also employed mice which were pretreated with subcutaneous carbaminoyl choline 15 minutes prior to subcutaneous administration of the drug under test. Carbaminoylcholine itself decreases the pupil size after half an hour. Gyermek[80] showed that pretreatment with carbaminoylcholine did not alter the mydriasis produced by atropine, scopolamine and other drugs having a postganglionic parasympathetic site of activity, but did decrease that induced by administration of true ganglion blocking agents, for example hexamethonium and mecamylamine. The mydriatic effect of compounds having both atropine-like and ganglion blocking properties was decreased to a variable but not significant extent by pretreatment with carbaminoylcholine.

Ciliary Ganglion

Perry and Talesnik (1953)[25] indicated that only three parasympathetic ganglia were of use in estimating parasympathetic ganglion blockade, namely the ciliary, the otic and the sphenopalatine. Of these, the ciliary ganglion has been the most commonly used, because it is relatively large and readily accessible. Experiments carried out by Langley and Anderson,[81] and Langendorff[82] and Apolant[83] showed that the ciliary ganglion was a relay station in the pupil-constrictor nerve tract. Whitteridge[94] has described the dissection of the ganglion and investigated the conduction of impulses through it, and his method has been the basis of most of the pharmacological work using this preparation. Cats were decerebrated and kept for 12 hours. Any reflex activity appearing was stopped by means of injection of sodium pentobarbitone which did not appear to affect the ganglion. (*cf.* Exley[85]). The third and fifth cranial nerves were cut close to the brain and the ganglion exposed by removing the left side of the skull in front of the tentorum cerebelli taking care not to injure the opthalmic artery. After having tied and cut the ethmoidal vessels, the orbital capsule was exposed. The superior rectus muscle was then divided and the short lateral ciliary nerve found and traced to the ciliary ganglion (see Fig. 11). The optic nerve was

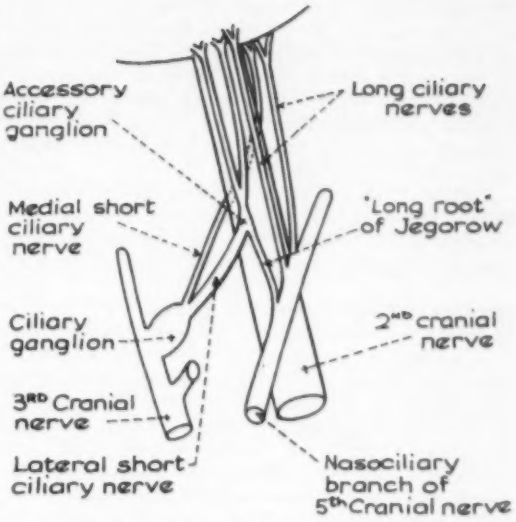

Fig. 11. Connections of the ciliary ganglion in the cat after Whitteridge[84] by kind permission of Prof. D. Whitteridge and the Editors of the Journal of Physiology.

then cut distally, the ciliary nerves divided and the eyeball removed.

Perry and Talesnik[25] have modified this method. They did not sever the optic nerve nor remove the eyeball, but pulled the latter forward by means of a thread through the cornea. The short ciliary nerve was identified, the optic nerve tied and cut and the oculomotor nerve cut close to its origin in the brain stem. All other branches to the ciliary ganglia were cut. Drugs were administered by means of retrograde arterial injection into the lingual artery on the same side by means of a needle cannula[86-88] thus leaving the carotid circulation intact.

The oculomotor nerve was stimulated by means of platinum electrodes at a frequency of one impulse every two seconds. The recording electrodes were placed one on the cut end of the postganglionic ciliary nerve and the other passed around the body of the ganglion nearer to the preganglionic than the postganglionic pole. Non-polarizable recording electrodes of the type described by Paton and Perry (1953)[24] were used and the ganglion action potentials recorded on one beam of a cathode ray oscilloscope using the other beam as a base line. By this means changes of potential in the ganglion could be recorded as beam deflections.

A further modification was made by Perry and Talesnik[25] who removed the superior cervical ganglion under aseptic conditions ten days prior to the experiment. No electrical recordings were made and the eyeball was immobilized by means of threads tied to a metal ring. The changes in the size of the pupil were measured on a graduated glass scale using a magnifying camera lens. Stimuli were applied at a frequency of ten impulses per second for a period of five seconds

alternately to the oculomotor and the ciliary nerves, i.e. to the post and pre-ganglionic fibres of the ciliary ganglion. Drugs were administered via the femoral vein or the lingual artery. Transmission in the ciliary ganglion could thus be investigated and an estimate made of parasympathetic blocking activity in ganglion blocking agents. The method is a qualitative rather than a quantitative procedure.

Schofield[89] removed both superior cervical ganglia and the ciliary ganglion on one side only. This provided a control (denervated eye) against the possibility of any injected compound having a direct action on the eye.

Inhibition of Ganglion Stimulant Activity

In 1951 Chen, Portman and Wickel[90] described the pharmacological properties of 1,1-dimethyl-4-phenylpiperazine iodide (D.M.P.P.) a substance possessing autonomic ganglion stimulant properties. These properties could be antagonized by ganglion-blocking drugs, for example TEA and hexamethonium. D.M.P.P. stimulated both sympathetic and parasympathetic ganglia and the inhibition of its spasmogenic properties on the isolated guinea pig ileum was used by Fakstorp and his colleagues[41-44] as a means of estimating parasympathetic ganglion blocking activity in a series of bischoline ethers. Leach[91] however showed that the height of contraction of the cat's nictitating membrane induced by sustained electrical stimulation was lessened by D.M.P.P. and Ling[92] demonstrated that on the isolated guinea pig ileum preparation it blocked the peristaltic reflex. Thus the lack of a purely stimulant action has seriously hindered its use as a laboratory agent in the estimation of ganglion blocking activity.

Pressure Changes in the Urinary Bladder

A method of estimating parasympathetic ganglion blocking activity by recording the pressure changes in the urinary bladder of the pentobarbitone-anaesthetized dog was first described by Cook and his colleagues in 1950.[93] Preganglionic fibres of the vesical branch of the pelvic nerve taken at as low a point as possible on the bladder wall were stimulated electrically for short periods of time. By means of a Krop[94] water manometer connected by a urethral cannula to the bladder, pressure changes in the bladder were recorded. The bladder was kept partially distended with normal saline. Cook and his co-workers[93] showed that ganglion blocking agents (for example, TEA) reduced the response of the bladder to mechanical distension by water and used this as a basis for an assay method.

The Lachrymation Response in Rats

Winbury and his colleagues (1949)[95] first described a method for estimating parasympathetic blocking activity based on the lachrymation response in rats.

Acetyl-β-methylcholine was used as a parasympathetic stimulant during the assay and was injected intraperitoneally into normal unanaesthetized rats at a dose level of 10 mg./kg. This produced a profuse lachrymal secretion tinged with blood, hence the so-called 'bloody tears' by which this experiment has come to be known. The rat is the species of choice because of its clear and easily recognizable response. The secretion of tears commenced about two minutes after injection of acetyl-β-methylcholine and continued for approximately five minutes after which time all evidence of lachrymation disappeared. The protection afforded by prior intraperitoneal administration of the parasympathetic blocking agent can thus be readily determined since the animal gives an all or none response. Potency is based on a comparison of doses of unknown and standard parasympathetic ganglion blocking agents which protect 50 per cent of the rats against intraperitoneal injection of acetyl-β-methylcholine.

Isolated Rabbit Heart with Sympathetic or Parasympathetic Nerve Supply

McEwen (1956)[96] described a method of qualitatively studying the effects of ganglion blocking drugs on the isolated rabbit heart. In these experiments, using the whole animal, the vagi were severed and dissected, the thoracic contents removed and the cardiac ends of the vagi and the heart itself cleared of tissue, leaving intact the root of the lungs and a piece of the trachea. The aorta was then cannulated and the heart perfused by the normal Langendorff procedure. It was found that hexamethonium abolished the inhibition caused by vagal stimulation.

Hükovic (1959)[97] carried out a similar type of experiment using isolated rabbit atria but keeping the sympathetic nerve supply intact.

Inhibition of the Cardiac Vagus

Stimulation of the pre- or post-ganglionic fibres of the cardiac vagus causes slowing of the heart rate. As the cardiac vagal ganglia are intra-mural, i.e. within the heart wall, it is not normally practicable to consider stimulating the post-ganglionic fibres, but Jacob and Depierre[98] during an investigation of ganglion blocking activity in a series of choline ethers investigated the ability of these compounds to diminish or abolish vagal bradycardia. Jacob and Depierre[98] used chloralose anaesthetized dogs and dissected and cannulated the trachea, external jugular vein and common carotid artery on one side. The cervical vagus on the other side was dissected and separated from the cervical sympathetic trunk. The vagus was then severed high in the neck and the cardiac end stimulated electrically. This procedure which causes slowing of the heart rate and inhibition of electrically induced vagal bradycardia, can be used to detect parasympathetic ganglion blocking activity.

Estimation of Combined Sympathetic and Parasympathetic Ganglion Blocking Activity

In 1956 Perry and Wilson[99] described a method of studying the activity of drugs acting concurrently on sympathetic and parasympathetic ganglia. The organ chosen was the cat heart, dually innervated, because both presynaptic nerve pathways are readily accessible

for stimulation. This method was evolved in an endeavour to overcome the difficulty of interpreting results of ganglion blocking activity obtained from different species and the difficulty of estimating the selectivity of a compound for either parasympathetic or sympathetic ganglia. For example, Paton and Zaimis (1951)[34] indicated that pentamethonium was more active on the superior cervical ganglion than on the guinea pig ileum. Perry and Wilson (1956)[99] showed that it blocked parasympathetic ganglia on the cat heart preparation.

Cats were used and were anaesthetized by chloralose after ethyl chloride and ether. The chest was opened on one side and the vagus and sympathetic fibres traced to the heart, artificial respiration being maintained during the procedure. Blood pressure was recorded from the femoral artery and pulse rate and pressure recorded on a kymograph by transmission through a cannula inserted into the carotid artery and connected to a rubber diaphragm. By means of platinum electrodes, presynaptic parasympathetic fibres to the heart were stimulated in the vagus while the corresponding presynaptic sympathetic fibres were stimulated between the second and third thoracic ganglia. A third stimulating electrode was placed on the postsynaptic sympathetic fibres in the accelerator nerve. The sympathetic and parasympathetic presynaptic nerves were stimulated alternately, drugs under test being administered intravenously via the femoral vein.

As a result of their experiments, Perry and Wilson[99] demonstrated no selective blocking action for TEA tetramethylammonium, hexamethonium or azamethonium, when used in doses which left post-synaptic transmission intact. They also showed that pentamethonium was much more selective towards parasympathetic than to sympathetic ganglia. This method has certain disadvantages, however, for example block of one part of the autonomic system may lead to increased activity of the other.

The Central Action of Ganglion Blocking Agents

Dontas and Nickerson[100] investigated in 1957 a central component of action which had been claimed for certain ganglion blocking drugs in addition to the well-known peripheral activity of these compounds. O'Dell and co-workers (1955)[101] using cross-circulation procedures in dogs, had noted that certain asymmetrical bisquaternary compounds had a hypotensive activity which was proportionately greater to their peripheral blocking activity than hexamethonium and suggested that an action upon the central nervous system was involved. Dontas and Nickerson[100] recorded potentials in the carotid nerve and the preganglionic portion of the greater splanchnic nerve in the cat, using electroneurographic methods.

The animal was anaesthetized by chloralose and urethane and after cannulation of the trachea was given artificial respiration. Neuromuscular block was produced by injection of decamethonium in order to eliminate muscle movement during the experiment. The right carotid and the right greater splanchnic nerves were dissected and freed, and electrical activity recorded from the distal stump of the former and from the proximal end of the latter. Dontas and Nickerson[100] concluded that ganglion blocking agents had a significant central blocking activity. Their view was not shared by McCubbin and Page[102] who used an essentially similar technique. Murray and co-workers[105] also used cross-circulation experiments on dogs. Their method was essentially a modification of the techniques of Nowak and Samaar (1935)[103] as described by Schneider and his colleagues in 1951.[104] From their work, Murray and his co-workers concluded that on the donor-isolated head system of the dog, doses of tetraethylammonium, hexamethonium, azamethonium, chlorisondamine and mecamylamine when used in doses producing ganglion blockade, did not significantly affect the recipient's blood pressure. This would tend to support the findings of McCubbin and his colleague[102] that effective ganglion blocking agents have little or no central effects.

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COMPLEXOMETRIC ANALYSIS

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PART IV—ANION ANALYSIS AND PHYSICAL METHODS

ALTHOUGH complexometric analysis can be applied only to cations, the method can be adapted for the indirect estimation of a number of anions. All that is necessary is for the anion to be replaced with an equivalent amount of a suitable cation. For example, sulphate may be analysed by adding excess standard barium chloride solution, filtering and washing the barium sulphate precipitate and titrating the excess barium with E.D.T.A. The determination of phosphate is another well established example and practical details are given for this in Experiment 1. The phosphate is precipitated as magnesium ammonium phosphate which, after separation, is dissolved in acid. Excess E.D.T.A. is added and the magnesium determined by a back titration. The presence of phosphate does not interfere with this titration—in fact, phosphates will not interfere with the analyses of most divalent metals but will interfere with tervalent metals as a result of complex formation.

Experiment 1

Reagents

Standard E.D.T.A. solution—approximately 0·01 M.
Standard magnesium solution—approximately 0·01 M
Eriochrome black T solution—0·1 g. of the solid indicator dissolved in 100 ml. water made alkaline with a few drops of ammonia.
Magnesium chloride solution—approximately molar.
Buffer solution for pH 10—7 g. ammonium chloride dissolved in 57 ml. 0·880 ammonia and made up to 100 ml. with water.

Procedure

An aliquot of the phosphate solution is made alkaline with dilute ammonia and the magnesium chloride solution is added dropwise until it is present in excess—no further precipitate is formed. The solution is allowed to stand for one to two hours and is filtered through a sintered glass crucible. After washing with 2 per cent ammonia solution, it is dissolved in the minimum quantity of 2 N hydrochloric acid. Excess E.D.T.A. is added and the pH is adjusted to 10 using a little methyl red as indicator. Five ml. of buffer solution and a little eriochrome indicator are added and the magnesium is titrated with the E.D.T.A. The end-point should be very sharp with a colour change from wine red to pure blue.

Another example of anion analysis involving two replacements is the analysis of halides (other than fluorides) by precipitation as the silver salt. Silver cannot be estimated directly with E.D.T.A. and a second replacement is required. The precipitated silver halide is dissolved in a solution of the tetracyano-nickel complex when the more stable silver cyanide complex is formed.

$$[Ni(CN)_4]^{2-} + 2Ag^+ \rightleftharpoons 2[Ag(CN)_2]^- + Ni^{2+}$$

In this reaction half the equivalent amount of nickel is liberated and this can be titrated with E.D.T.A. at pH 10 using murexide indicator. Full details are given below in Experiment 2.

Experiment 2

Reagents

Standard E.D.T.A. solution—approximately 0·01 M.
Murexide solution—0·1 g. of the solid indicator dissolved in 100 ml. water.
Buffer solution for pH 10—as for Experiment 1.
5 per cent silver nitrate solution.
Potassium nickel tetracyanide $K_2[Ni(CN)_4]$

Procedure

An aliquot of the halide solution is made acid with nitric acid and brought gently to near the boiling point. Silver nitrate solution is added dropwise until no further precipitate is formed and the solution is allowed to stand for about an hour. The precipitate is filtered through a sintered glass crucible and washed with very dilute nitric acid. The crucible is then transferred to a beaker, about 100 ml. water added and the pH brought to 10 by addition of ammonia. About 0·5 g. potassium nickel tetracyanide is added and the beaker allowed to stand until the precipitate has dissolved. It may be necessary to warm the solution, particularly in the analysis of iodides. Five ml. buffer solution and a little murexide solution are added and the liberated nickel is titrated with the standard E.D.T.A., the colour changing from violet to yellow at the end-point.

With considerable ingenuity, this type of procedure has been applied to a variety of other analyses. Thus, although the monovalent alkali metals do not form stable complexes with E.D.T.A. it has been shown by Flashka (1952) that sodium may be precipitated quantitatively with zinc uranyl acetate and the zinc titrated with E.D.T.A. In the same way, potassium has been determined by Flashka and Holasek (1956) by precipitation as the cobaltinitrite followed by estimation of the cobalt. Acetylene has been determined by absorption from a gas stream into a copper solution and analysis of the copper in the precipitate by E.D.T.A. This is one of the fields in which E.D.T.A. analyses

offer considerable scope and in which these are being developed and improved.

In all the E.D.T.A. applications considered so far, the end-points have been detected with metal sensitive chemical indicators. A large number of these are available and it can be assumed that many others will be developed, but this is not the only way of detecting these end-points. A number of physical methods based on changes in electrical or optical properties have been proposed and these have sometimes proved to be more sensitive and easier to operate.

E.D.T.A. forms coloured complexes with a number of metals and a spectrophotometric method for the end-point has been developed for some analyses. For example, copper forms a coloured complex and the titration may be followed directly in this way. Complexes of other metals, such as bismuth are not coloured, but absorb at wavelengths in the ultra-violet and so spectrophotometric end-point detection is still possible. Indirect procedures based on the fact that E.D.T.A. itself shows strong absorption, particularly at high pH values, can be used with a number of other metals including calcium and magnesium. The end-point is shown by increased absorption due to the presence of free E.D.T.A. in the solution. Where coloured complexes are not formed, spectrophotometric procedures can be used in conjunction with a coloured indicator and many indistinct visual end-points prove to be remarkably accurate if followed at the right wavelength in this way. This has been developed successfully with some of the usual indicators such as murexide and with other specific indicators such as salicylic acid in the titration of iron.

Replacement procedures have also been proposed. Barium can be precipitated as barium chromate which is dissolved in E.D.T.A. and estimated colorimetrically. It has been shown by Underwood (1954) that it is possible to analyse mixtures of cations in this way, provided that the stabilities and absorption properties of the complexes differ sufficiently. For example, this has been carried out successfully with bismuth and lead. The bismuth E.D.T.A. complex is much stronger and is formed preferentially. If the absorption is measured at 240 mμ, there is a gradual increase while the bismuth complex is formed, followed by a rapid increase while the lead complex is formed (due to much stronger absorption by the lead complex).

The method is very sensitive and can be applied to metal concentrations as low as 0·0001 M in favourable circumstances. In many ways, it is less subject to interference than chemical indicators and Sweetser (1954) has described applications to the analysis of ores and alloys.

Potentiometric end-points have been used but are only applicable, in an unmodified form, to a limited number of metals. For a system expressed by a general equation of the type,

$$\text{oxidized state} + ne \rightleftharpoons \text{reduced state}$$

the potential is given by the equation,

$$E = E_o + \frac{0{\cdot}059}{n} \log \frac{[\text{oxid}]\, K_{red}}{[\text{red}]\, K_{oxid}}$$

where [oxid] and [red] represent the concentrations and K_{oxid} and K_{red}, the corresponding stability constants.

Using a direct E.D.T.A. titration, this method has been used successfully for the estimation of iron (III) and copper (II), the main requirements being that the oxidation-reduction system be readily reversible and that the E.D.T.A. complexes with the oxidized and reduced ions have sufficiently different stabilities. The scope of the method can be extended to include aluminium, nickel and some other metals by adopting a back titration technique with a standard iron (III) solution. In all these titrations platinum and calomel reference electrodes are used, the reference electrode being directly in contact with the solution or connected through a salt bridge.

Reilley and co-workers (1956) have developed a potentiometric method which is almost universally applicable. Instead of the platinum electrode as in the usual technique, an electrode is used consisting of metallic mercury in contact with a small amount of the mercury(II)-E.D.T.A. complex. The potential exhibited for a metal M^{n+} corresponds to the following half cell:

$$\text{Hg/Hg(II)-EDTA} \;/\; \text{M-EDTA} \;/\; M^{n+}$$

$$E = E_o + \frac{0{\cdot}059}{2} \log \frac{[\text{Hg-EDTA}]\,[M^{n+}]}{[\text{M-EDTA}]\, K_{Hg}} K_M$$

where [Hg-EDTA], [M-EDTA] and $[M^{n+}]$ represent the concentrations in each case and K_M and K_{Hg} represent the stability constants of the metal and mercury EDTA complexes respectively. [Hg-EDTA] is constant and near the end-point [M-EDTA] may also be taken as constant, making the potential proportional to $[M^{n+}]$ and therefore to pM. The method is, in many ways, analogous to an acid-base titration followed potentiometrically with a glass electrode.

Experimentally, the mercury electrode consists of a J-shaped glass capillary tube with a drop of mercury in a cavity at the lower end or a mercury amalgam gold electrode may be used. It is used in conjunction with a calomel reference electrode which, as above, may be in contact with the solution or connected through a salt bridge. A large number of metals can be titrated at pH values from 2 (for the very stable complexes) to 11 (when mercury hydroxide is formed). Chloride is the main interfering anion due to the formation of stable mercury chloro complexes.

The procedure is quite simple. The metal solution is buffered to the required pH, a very small amount of mercury(II)-E.D.T.A. complex is added and the two electrodes inserted. The solution is then titrated with standard E.D.T.A. and the voltage across the electrodes measured with a potentiometer (a commercial pH meter is quite suitable). At the end-point the voltage rises sharply as E.D.T.A. is added. The method is a very

accurate one, giving good end-points, and is applicable to a large number of metals.

End-points have also been detected polarographically. The formation of an E.D.T.A. complex causes a shift in the half-wave potential and this has been used for the direct and indirect determination of a number of metals. The displacement is related to the strength of the metal-E.D.T.A. bond and so will vary with the metal. This has been used as a means of separating and distinguishing between metals having potentials too close for accurate analysis.

Most of the other electrical methods of end-point determination have been used successfully, although in a limited number of cases. Thus conductimetric titrations have proved very satisfactory for some metals, particularly those forming complexes in the pH range 5 to 6. High frequency titrations have been used for others enabling accurate analyses to be made on solutions of very low concentrations.

An attempt has been made in the complete survey (Parts I to IV) to describe the important methods and applications of complexometric analysis. It has not been practicable to describe many individual analyses but these can either be carried out from the examples that have been quoted or the original reference traced quite easily from the bibliography and literature on the subject. E.D.T.A. and similar substances have proved to be very powerful analytical tools, easily applied with inexpensive apparatus and, for the most part, not requiring an abnormal amount of skill or experience. It is difficult to predict which methods or applications will become more important. Chemical indicators are being developed in ever increasing numbers but, on the other hand, specially designed apparatus for photometric end-point detection is being sold and the Reilley potentiometric method has been suggested as the basis of a universal automatic analyser.

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BOOK REVIEWS

Rheology—Theory and Applications, edited by Frederick R. Eirich. Vol. III. New York and London: Academic Press. 1960. pp. 680 + xvi. $21.

It was originally intended that this third volume should complete this treatise on Rheology, but it now seems likely that it will be followed by a fourth.

Volume III maintains the high standard of its predecessors. It is a pity that it has not been possible to agree on a unified nomenclature but the list of symbols appended to the chapters largely meet this criticism.

The volume opens with a chapter by B. H. Zimm on new model for polymer chains in dilute solution. This is worthy of special mention, since it is remarkable for its clear and intelligible writing on an intricate theme. S. Oka's 'Principles of Rheometry' is a masterly summary compressed into some 60 pages, although opinions will differ as to whether the straightforward classical treatments for true fluids need to be printed out yet again. It might have been more valuable to include some mention of the voluminous recent work on measurements of anomalies in Poiseuille's fourth-power radius law in capillary flow, which appear to be so important both in biological and in inorganic systems. It is also strange that these anomalies are not mentioned by Dr. Ruth Weltmann in her excellent chapter on pastes and paints, especially since it was in paints that they were first noticed. Her section on dilatancy needs revision in view of recent work; and one wonders how 'the close-packing effect' (close-packed spheres must expand into more open packing before shearing) can be 'counteracted' by a surface-active agent (though the dilatation may, of course, be eased in some way).

A chapter on rubber latex again reproduces much of the classical theory of flow, but is otherwise interesting. That on printing inks tells us just how these materials are used in practice as well as tested rheologically. One might question whether it is wise to define 'shortness' as the ratio of yield-value to plastic viscosity, a definition which would describe most metals as almost infinitely short; but perhaps they are!

Other chapters include an able summary of the very complex electroviscous effects by B. E. Conway and Mme. A. Dobry-Duclaux, a summary of work on concrete and its components by M. Reiner, an account of two-dimensional rheology by D. W. Criddle and chapters on lubrication, adhesion, moulding and spinning by other authors.

In this review, it has hardly been possible to do justice to such an important contribution to rheology. 'Eirich' is already a classic and will remain so for many years to come.—G. W. SCOTT BLAIR.

The Author's and Writer's Who's Who, Fourth Edition, London: Burke's Peerage Ltd. 1960. pp. 454. 45s.

This new edition, the second since the war, has been edited by L. G. Pine, Editor of Burke's Peerage, and the same thoroughness in treatment has been applied to both books. The usual information has been set out in clear type in a handsome volume which is surprisingly light for its size.

It is symptomatic of the times that a large proportion of the entries are of scientists and technologists. Most scientists, engineers and medical men who have written a book appear in this work. In the absence of a scientists' 'Who's Who' this volume is therefore of considerable interest and usefulness.—J. G. DAVIS.

Quantitative Paper Chromatography of Steroids (*Memoirs of the Society for Endocrinology, No. 8*), Edited by D. Abelson and R. V. Brooks. Cambridge: University Press. 1960. pp. 103 + vii. 30s.

The advantages of paper chromatography are apparent to all, the disadvantages are only encountered in the practice of the art. Not only the convenience of this versatile technique but also its scope and the economy of effort, which permit several simultaneous analyses, commend it to all who do not require absolute precision. In these memoirs which set out the experiences of several contemporary groups applying quantitative paper chromatography to diverse steroid problems the emphasis is appropriately on the measurement of separated compounds rather than on problems of resolution. Yet adequate resolution is an absolute pre-requisite for quantitative assay and the problem of defining the limits of adjacent spots has been emphasized by many contributors.

The reader will find no ready-made solution of his personal problems but will quickly recognize the salient and critical factors which are uniquely associated with quantitative work on paper. The publication deals with such criteria as factors influencing the choice of solvent systems, the location and measurement of spots, the respective merits of chemical and physical methods of measurement and perhaps, most important of all, the problem of whether to measure *in situ* or to elute and measure in solution. Quantitative elution of compounds from paper appears to be almost incompatible with low blank values and it is perhaps here that the use of isotopic labelling is most rewarding. Paradoxically the conclusion is reached that paper is not an ideal medium for paper chromatography.

Perhaps the least satisfactory feature of this publication is that the memoirs are based upon a meeting held in 1958. That two years should be necessary to get this kind of report into print is no credit to the society or to the publishers. The delay has not prevented errors appearing in the text.—A. E. KELLIE.

Methods of Testing Chemicals on Insects, edited by Harold H. Shepard. Vol. II. U.S.A.: Burgess Publish-Co. 1960. pp. 248 + iii. $5.

The second volume of this work is chiefly devoted to the description of methods for screening candidate compounds for specific purposes—for use in space sprays, soil insecticides, insect-proofing agents for textiles and packaging materials, and insect attractants and repellents, or for external or internal administration to livestock for control of their insect pests; and although not strictly within the scope indicated by the book's title, a chapter on testing acaricides is reasonably included. However, three short opening chapters are of a more general kind, discussing how various conditions to which experimental insects are subjected influence the toxic effects observed.

Although in general more up-to-date than the first volume, this second volume is otherwise open to much the same criticisms. The 13 chapters, written by different specialists, vary greatly in both quality and style. Certain chapters are lucid and readable, e.g. those concerning space sprays and insecticides for use against livestock pests, but certain others degenerate in places into monotonous summaries of literature taken paper by paper. The contributors required more briefing and their contributions more editing in order to achieve an even, balanced presentation of the subject. For what will be mainly a work of reference the index is very inadequate.

Printing and illustrations are good.—P. S. HEWLETT.

Radioactive Tracers in Chemistry and Industry, by Pascaline Daudel (translated by Ulli Eisner) London: Charles Griffin & Co., Ltd. 1960. pp. 210 + xi. 36s.

This little book is a translation of Madame Daudel's French text of 1955, revised and supplemented with a chapter on industrial applications by N. Robinson. It does not deal with biological applications of radioactive tracers neither does it include any treatment of fundamental phenomena. It is described as an introductory text and a useful guide for chemical analysts, industrial tracer workers, and honours degree students. The five chapters deal with general principles, application to reaction mechanisms, exchange reactions, uses in analysis and uses in industry.

Any addition to the numerous books in this general field necessarily invites rather critical scrutiny. The first chapter deals with a few examples of isotope production and labelled compound preparation, giving undue space to Szilard-Chalmers reactions and the synthesis of acetic acid-1-C14, but omitting any useful account of isotope production processes which are of practical importance; it is, for example, misleading to imply that the neutron irradiation of ammonium nitrate solutions is a useful source of carbon-14. 'Hot-atom' syntheses of carbon-14 compounds are mentioned briefly but with no indication of the severe limitation of the specific activities attainable, which greatly reduces the practical value of this approach. There are many references (a praiseworthy feature for a small book), but they do not include any references to tritium labelling, Wilzbach labelling, biological labelling, or to the important general text of Murray and Williams (1958). Radioactive measurement is dealt with in seven pages and this is necessarily a very compressed account. Exchange reactions and isotope effects are also briefly treated in this chapter.

Chapter II, on reaction mechanism studies, is rather more extensive and more fully documented. The important textbook of Burr (1957) is however not mentioned; and there is a sad mis-statement on the Willgerodt reaction (page 44) from failure to note the subsequent work on this subject of Brown, Cerwonka and Anderson (1951, and later papers).

The third chapter, on exchange reactions, is the most extensive treatment and is particularly fully documented. One may suspect that this subject is the author's main interest.

Chapter IV on analysis covers the methods in

general use, but one would like to see a wider range of examples quoted for dilution analysis applied to complex organic mixtures; and the example chosen to illustrate a radioactive organic reagent is not a particularly good one. It is not made clear that the carrier dilution method is independent of quantitative separation, the unique merit of this method of analysis. The limit set to the accuracy of most tracer methods of analysis by the error of measurement is not mentioned.

The chapter on industrial uses resembles many such reviews. The single reference given to polymerization studies hardly does justice to the useful applications of tracers in this field.

An appendix gives details of four experiments suitable for inclusion in a course of instruction.

The reviewer has some difficulty in envisaging the reader to whom this book is addressed. It is not really comprehensive in scope and the treatment of some of the specific topics is hardly adequate. The revision would not appear to have covered properly the interval of five years since the French original appeared, and there are a number of blunders and odd expressions which are partly, no doubt, attributable to translation. Ethyl and ethylene iodides are described as water-soluble (page 7) where clearly the reverse is meant. The titles of publications quoted, translated into French for the original edition, appear to have been re-translated into English without checking with the originals. This produces some curious results, such as the reference (page 85) to the fumigant methyl bromide as a 'smoke producer'. One reference at least (page 30) has slipped through without re-translation. The section on frictional wear (page 155) begins with what seems a quite irrelevant sentence. The half-life of sulphur-35 (page 32) is not 24 days, but 87 days, as is stated correctly in the appendix. The expression 'neutron transparence' is unfamiliar (page 122). There is no discussion of the possible sources of error in interpreting the results of tracer experiments, of which the Willgerodt reaction referred to above is a noteworthy example, nor of the relative and absolute toxicities of radioactive isotopes. Despite the wealth of references it is not easy to select rapidly from them the most useful general texts on tracer methods.

'Radioactive Tracers in Chemistry and Industry' is an interesting book, the most commendable features being the treatment of exchange reactions and the plentiful literature references. The reviewer is however disappointed in it, and the reader using it as an introductory text will need to supplement it considerably by further reading.—J. R. CATCH.

British Society for Immunology

The Society will meet at the Wellcome Building, 183 Euston Road, London, N.W.1, on November 25-26. On November 25 there will be a Symposium on 'The Stimulation of Antibody Production in Man and Animals' and free papers will be read on November 26. Details from Dr. R. G. White, Department of Bacteriology, The London Hospital, E.1.

British Biophysical Association

A Steering Committee, originally appointed as a working party by The Faraday Society to consider the future of its work in the field of biophysics, has decided to launch a new and independent Society to be known as the British Biophysical Society. The Chairman and Secretary of the Steering Committee are Prof. J. A. V. Butler and Dr. J. C. Kendrew respectively. The first scientific meeting of the new Society will take place in London in December 1960.

Forthcoming Conferences

International Symposium on Inorganic Polymers

A Symposium on Inorganic Polymers, sponsored by The Chemical Society, will be held at the University of Nottingham from July 18-21, 1961. The Symposium will consist of Main Lectures and Contributed Papers, and the Opening Address will be given by Dr. J. S. Anderson, F.R.S. (National Chemical Laboratory, Teddington).

Speakers who have agreed to give Main Lectures include J. C. Bailar (University of Illinois), A. B. Burg (University of Southern California), G. Gee, F.R.S. (University of Manchester), A. W. Laubengayer (Cornell University), O. Schmitz-DuMont (University of Bonn), and E. Thilo (Deutsche Akadamie der Wissenschaften, Berlin). It is hoped that one of the main lectures will also be given by a speaker from the U.S.S.R.

The number of contributed papers has had to be limited and persons wishing to present a paper should submit the title and a summary of about 250 words not later than January 1, 1961, to the Secretary, International Symposium on Inorganic Polymers, Department of Chemistry, University of Nottingham, Nottingham, England. Each speaker will be allowed 15 minutes to present his paper, and there will be time available for discussion.

Contributed papers will be divided into the following sections:

1. Polymers containing transition metals (including coordination polymers, polyacids, etc.).
2. Polymers containing a Group III element (e.g. polymeric compounds of boron or aluminium).
3. Polymers containing a Group IV element (including polymetallosiloxanes, silicones, silicates, etc.).
4. Polymers containing a Group V element (e.g. polymeric compounds of nitrogen and/or phosphorus, and the polyphosphates).
5. Polymers containing a Group VI element (e.g. the homochain and heterochain polymers of sulphur).
6. Other aspects not conveniently classified under any of the above sections (e.g. analytical methods).

Many heterochain polymers fall into more than one of the above sections, but closely related types of polymers will, as far as possible, be grouped together in the programme. The term 'inorganic polymer' will be interpreted widely, and does not necessarily imply polymers containing only elements other than carbon. However, papers dealing solely with conventional organic polymers would not be appropriate. Although the main emphasis will be on the preparation and reactions of inorganic polymers, it is intended to include also the theoretical and physical aspects, such as thermal stability, and mechanisms and kinetics of condensation.

A programme of interest to ladies accompanying participants will be arranged.

The full programme and forms of application to attend the Symposium will be available in March, 1961, from the General Secretary, The Chemical Society, Burlington House, London, W.1.

An Electrically Heated Micro-digestion Apparatus

by J. W. Porteous, Ph.D.,

Department of Biological Chemistry, Marischal College, Aberdeen

THE construction of a simple and robust electrically heated micro-digestion apparatus is described. The apparatus will take 15-30 ml. Kjeldahl digestion flasks, 19 mm. × 160 mm. tubes, 12 mm. × 75 mm. tubes, or crucibles. The heating elements are domestic fire spirals controlled by a four-position switch and the apparatus is so designed that the elements can be replaced quickly if necessary. Most of the materials used in construction are resistant to acid corrosion.

In outer appearance the apparatus (Fig. 1) consists of an asbestos pipe sandwiched and supported between two triangular end-plates of Syndanyo which are held together by bolts passing into three brass bars. The uppermost of these bars carries a series of spring clips to hold test tubes or the necks of digestion flasks. The lower brass bar carries smaller clips to hold small Pyrex test-tubes; alternatively crucibles may be placed in the holes of the asbestos pipe. Small v-shaped nicks are cut on either side of each of these holes in line with the axis of the pipe; these nicks, together with $\frac{1}{2}$ in. diameter holes drilled through the pipe diametrically opposite the upper holes, allow free passage of air across the heating elements (housed within the pipe) and past the bowls of the digestion flasks or crucibles. The asbestos pipe is loosely supported at its two ends on circles of $\frac{1}{4}$ in. thick Syndanyo fixed permanently to the inside surfaces of the two end-plates which are also cut from $\frac{1}{4}$ in. Syndanyo (Fig. 2); a small slot cut into one end of the asbestos pipe locates on the free end of a bolt fastened through one of the end-plates and prevents the pipe from rotating.

The construction of the frame to carry the heating elements and the method of attaching this frame to one of the triangular end-plates and to the switch to form a structural unit, is shown in Fig. 2. Two threaded brass rods are passed through holes drilled through one of the end-plates and through the circle of Syndanyo bolted to its inner face; lock nuts are screwed up on either side of the Syndanyo leaving an approximately 1 in. length of each rod projecting from the outer face, and 14 in. lengths projecting beyond the circle of Syndanyo on the inner face of the end-plate. A circle of Syndanyo, drilled with appropriate holes, is passed on to the shorter projections of the threaded rods followed by the rotary switch which is retained by nuts.

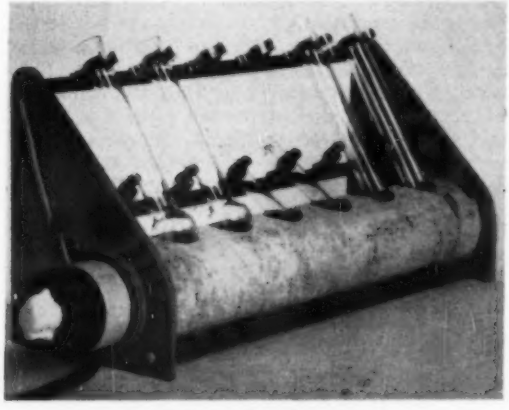


Fig. 1. The completed apparatus.

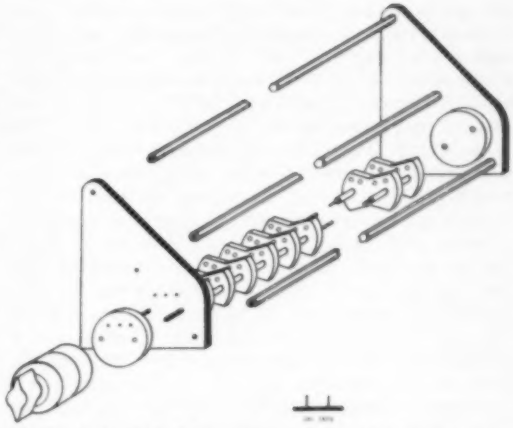


Fig. 2. An 'exploded' isometric projection of the components of the digestion rack. The asbestos pipe surrounding the support for the heating elements has been omitted as also have the elements themselves; the latter pass through the four vacant holes shown near the upper edge of each disc.

On to the longer projections of the threaded rods are passed an alternating series of $\frac{3}{8}$ in. long spacers (in pairs) and of $\frac{1}{4}$ in. thick circles of Syndanyo from each of which two diametrically opposed sectors are cut away as shown in Fig. 2; two holes are drilled through each disc to pass the threaded rod, and four holes, each of a diameter to pass easily a 500 W. domestic fire spiral, are drilled through each disc just below the edge of one of the sectors as shown in Fig. 2. The disc nearest the rotary switch is drilled with a further four holes to carry terminals; this disc is placed against the lock nuts on the inner face of the circle of Syndanyo bolted to the end plate. The succeeding series of 12 spacers and 12 discs is locked in place by nuts beyond the last disc in the series. The 13 equally spaced discs

are thus arranged so that there is one across the diameter of each upper hole in the asbestos pipe and one on either side of each hole; the support for the heating elements so formed is a loose sliding fit inside the asbestos pipe and structurally quite independent of the pipe and of the end-plate at the remote end of the apparatus.

The heating elements consist of two 500 W. domestic fire spirals of unstretched length approximately 11 in. Each spiral is carefully stretched to approximately 28 in. and a ½ in. length at each of the four free ends is straightened out. A 1 in. length in the centre of one spiral is also straightened out, the two sections of this element passed through the inner pairs of holes in the series of discs (Fig. 2), and the free ends fastened to the corresponding terminals. After straightening a 1½ in. length in the centre of the second element, its two sections are similarly threaded through the outer pairs of holes in the series of discs and taken to the outer pair of terminals. A pair of terminals is shorted with heavy-gauge copper wire so as to connect the two elements in series; two heavy-gauge asbestos-sleeved wires are led from the two individual terminals and a third similar wire from the common terminals, through holes in the end-plate (Fig. 2), to the appropriate terminals in the rotary switch. The metal parts of the outer structure of the apparatus are wired together (Fig. 1) and taken to earth *via* a three-core rubber-sheathed cable and a fused three-pin plug top.

To assemble the apparatus, the asbestos pipe, large holes uppermost, is slipped over the heater frame and seated on the circle of Syndanyo bolted to the inner face of the end-plate carrying the switch. The three hexagonal bars are bolted to this end-plate. The other end-plate is then brought up to the open end of the asbestos pipe which seats on the circle of Syndanyo fixed to this end-plate (Fig. 2); three bolts are passed through this second end-plate into the hexagonal bars to complete the assembly. Dismantling for electrical servicing requires only the removal of these latter three bolts, thus allowing removal of the end-plate and withdrawal of the asbestos pipe to expose the entire length of the heating elements and the terminals.

Rotation of the rotary, snap-action switch from 'Off' to position 1 places the two heating elements in series; sufficient heat is then generated to remove water from the flask or tube contents without violent boiling. At position 2 of the switch only the inner element is functional and sufficient heat is then generated to complete all but the most refractory Kjeldahl digestions. At position 3, the inner and the outer elements are placed in parallel; for Kjeldahl digestions the heat generated is then excessive except for final 'clearing' of an obstinate digest.

ACKNOWLEDGMENT. — *The author is grateful to Mr. A. G. Silver for his help in the design of the apparatus and for his work in constructing a set of six racks. Fig. 1 is reproduced from a photograph by Mr. J. Jamieson.*

An Automatic Dosage Apparatus

by F. S. H. Abram

Salmon and Freshwater Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food

A SIMPLE dosage apparatus has been developed for preparing solutions of known concentration. No external power source is required, the device being operated by the filling and automatic emptying of a vessel with diluent water. The vessel is a wide-mouthed 1 l. Erlenmeyer flask, which has a 'T' piece sealed into the base. This 'T' piece is connected to a siphon tube by a short vinyl tubing sleeve as shown in Fig. 1. A break pipe is carried from the siphon bend into the flask.

The diluent water is fed into the apparatus at an approximately constant rate, a glass float rising and falling as the flask fills and empties, moving vertically in a guide made from polythene sheet and tube. A 'T' piece is attached to the float, a short length of 'Symel' silicone rubber tube being carried on each of the 'T' piece arms. The upper tube is linked to a short length of glass tube, which is fixed in position, and is in turn connected to a supply of stock solution. The lower silicone tube links with a glass tube discharging into the flask, while the tube from the side arm is connected to a burette. The up and down movement of the float alternately kinks the tube connecting the stock of solution to the 'T' piece, and the tube leading from the 'T' piece to the flask, so that the burette fills and empties with the filling and emptying of the flask (Figs. 2 and 3).

The volume delivered by the syphon is adjusted to a suitable value (in the present case to 1 l.) by sliding the break pipe up or down through the rubber bung in the base of the apparatus; and the volume can be checked by collecting the discharge water in a graduated cylinder, or more conveniently, by placing a Rotameter (flow meter) in the water supply line. Thus, if a delivery of 1 l. per minute is required, the flow meter is set to this rate, and the break tube adjusted until the apparatus syphons over at one minute intervals. The volume delivered by the burette can be adjusted by moving a graduated capillary tube up and down through the rubber bung in the top of the burette. If a N/100 solution is required, the syphon volume is set to 1 l., the stock aspirator filled with N/1 solution, and the burette adjusted to deliver 10 ml.

Glass parts were made to order by James A. Jobling Ltd., and the total cost was about £2 per unit.

The apparatus was developed for dosing toxic solutions through tanks containing fish, and has worked reliably for long periods without attention.

AUTOMATIC DOSAGE APPARATUS

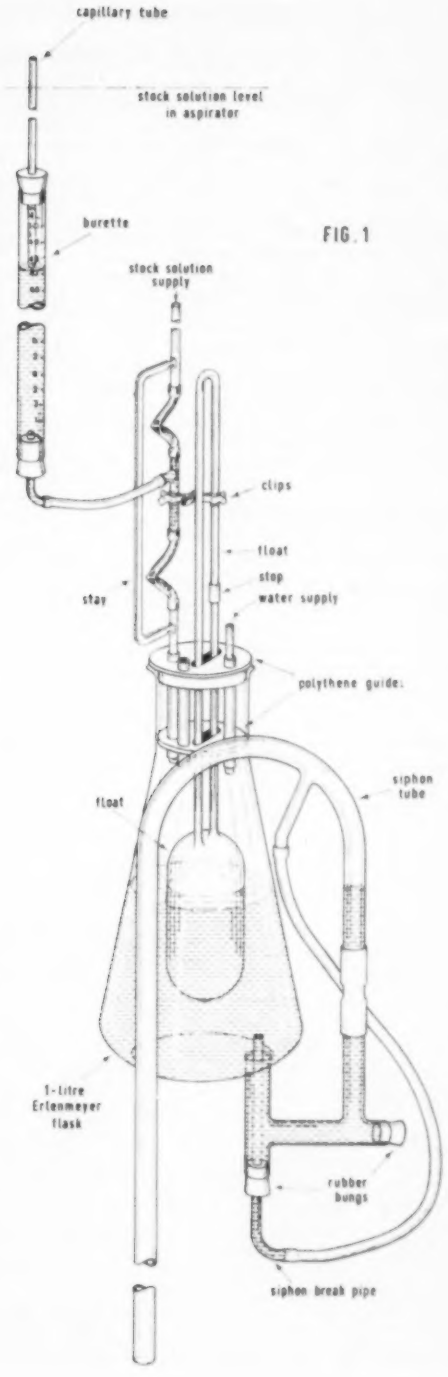


FIG. 1

FIG. 2

Burette filling from aspirator

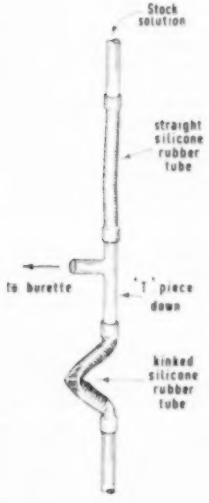


FIG. 3

Burette emptying to flask

NOTE THE CLIPS HOLDING THE SIPHON TUBE TO THE NECK OF THE FLASK HAVE BEEN OMITTED FOR CLARITY

An Automatic Recording McLeod Gauge

by R. C. Asher and M. Moreton-Smith

Atomic Energy Research Establishment, Harwell, Berks.

THIS device was used in studying changes in gas pressure in the range 0·1-100 μ Hg. occurring in a closed system over periods of several days. It recorded pressure automatically, was built mainly from proprietary units and was quite simple in operation. The principle (Fig. 1) was to use a simple timer to operate a McLeod gauge at regular intervals and to photograph the McLeod scale at each cycle.

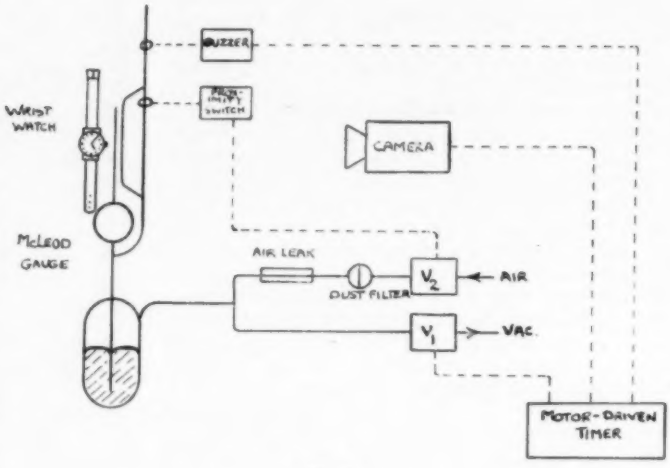


Fig. 1.

An 'air lift' type gauge was used. Air was admitted to the mercury reservoir through the air leak, but between readings the mercury was prevented from rising by simultaneously pumping through magnetic valve V_1. Every 15 minutes, which was a convenient interval between readings, a timer closed V_1 thus permitting the mercury to rise slowly. As the mercury approached its maximum position the timer brought into operation a buzzer attached to the gauge and thus prevented the mercury sticking in the capillary. (The timer switched off the buzzer before a photograph was taken.) The mercury was stopped at the required position, i.e. at the zero of the scale, by using a proximity switch with its probe attached to the gauge as shown, and arranged to close magnetic valve V_2. The position of the probe had been adjusted so that the mercury came to rest at the zero of the scale. The air leak was chosen so that the mercury took about eight minutes to rise. A minute or so later the timer energized the camera which photographed the scale and an adjacent wrist watch, thus giving a record of pressure and time. Finally the timer opened V_1, lowering the mercury to its original position and thus opening V_2. The system had now returned to its initial state and was ready for the next cycle. At the end of the experiment the film was processed, examined in a simple viewer, and the pressure and time read off. A correction was made to the pressure readings to allow for parallax between the mercury and the scale.

Components: McLeod gauge—Edwards bench model. Camera—an electrically operated recording type, e.g. Siemens Model Fot kika 9b. Proximity switch—Fielden 'Tektor'. Timer—a 4 r.p.h. synchronous motor driving three cams which operate micro switches; it was mainly made of Meccano components.

Recent British Standards

The Analysis of Copper Alloys

Three parts of a new British Standard with the collective itle 'Methods for the analysis of copper alloys' have been published by the British Standards Institution. They are Parts 6, 7 and 8 of B.S.1748 dealing respectively with the determination of tin (nickel coil reduction method), silicon photometric method), and phosphorus (photometric method) (Price 3s. each part).

The methods are intended primarily for use in the analysis of the copper alloys specified in B.S.1400: 'Copper alloy ingots and castings' and those to be dealt with in the series of schedules of wrought copper and copper alloys—B.S. 2870 to B.S.2875.

Part 6 specifies reagents required, recommended methods of sampling, and test procedure for the determination of tin in alloys having a tin content between 1·0 and 14·0 per cent. The method is applicable to phosphor bronze and gun metals.

Part 7 specifies reagents required, recommended methods of sampling, and test procedure for the determination of silicon in alloys having a silicon content between 0·005 and 0·2 per cent. The method is applicable to phosphor bronze and gun metals.

Part 8 specifies reagents required, recommended methods of sampling and test procedure for the determination of phosphorus in alloys having a phosphorus content up to 1·20 per cent. The method is applicable to all types of copper alloys, provided a suitable compensating solution is used when elements are present which would otherwise nterfere with the optical density determination.

Parts 1-5 of the standard (dealing in one volume with copper, lead, iron, aluminium and nickel) will be issued shortly.

Copies of this Standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London W.1.

Laboratory Note-book

H.R.H. PRINCE PHILIP, Duke of Edinburgh, has been graciously pleased to become Patron of the Society for Visiting Scientists.

The Society, which came into existence during the war, offers at its house, 5 Old Burlington Street, London, W.1, a centre at which foreign and overseas scientists visiting the United Kingdom may meet informally with other visitors and with British scientists.

The President of the Society is Prof. A. V. Hill, C.H., O.B.E., Sc.D., F.R.S., and Council of Honour Prof. Niels Bohr, For.Mem.R.S., Denmark; Dr. Detlev, W. Bronk, O.B.E.(Hon.), For.Mem.R.S., U.S.A.: Sir Macfarlane Burnet, O.M., F.R.S., Australia; Sir Henry Dale, O.M., G.B.E., F.R.S., Great Britain; Prof. Jacques Hadamard, For.Mem.R.S., France; Sir Kariamanikkam Srinivasa Krishnan, D.Sc., F.R.S., India; Prof. Wilder Penfield, O.M., C.M.G., F.R.S., Canada; and Dr. Salimuzzaman Siddiqui, Pakistan.

The Society provides club and restaurant facilities and there is accommodation for overnight stay for a limited number of visitors. There is a small library. Contact is maintained with a large number of scientists abroad and through its information service and in other ways the Society is able to assist the activities of scientists on short visits to this country, as well as, occasionally, those of British scientists travelling abroad. Students from overseas, studying in England are brought together in the activities of the Overseas Science Students Association for which the Society provides a home.

The work of the Society is made possible by the subscriptions of its British members, a generous grant from the British Council and donations and covenanted subscriptions from industrial and other bodies interested in fostering a closer understanding between scientists of all countries.

Help for the Science Teacher

One of the principal lines of research in the establishment of Griffin and George (Research and Development) Ltd. is to devise new equipment, or test possibly useful equipment, which will assist the modern teacher of science in the demonstration of scientific principles to his pupils.

A new series of units have, therefore, been devised to give simple yet convincing demonstrations of the fundamental electrodynamical principles and the working principles of electromagnetic instruments.

One group, based on an Alcomax high coercivity and intensity magnet, which withstands rough usage and produces easily observable effects, when used in conjunction with auxiliary units, demonstrates the production of eddy currents, Fleming's left-hand rule and the principles of the dynamo, electric motor and moving coil meter.

A special multi-turn coil so wound that all the tappings have identical mean diameters is the basis for demonstrating magnetic induction and some of its applications.

When the two basic units are combined quantitative determinations such as the force on a conductor can be clearly made with a 500 g. balance or torsion assembly.

By making full use of transparent plastics all working parts, wires and connections are visible. Terminal sockets are easily distinguishable and clearly marked, and where required, have wander plugs. Slotted bases enable units to be linked together. One magnetic assembly for example, can be used for five different demonstrations, thus reducing costs.

Further units employing the multi-turn coil and magnetic assembly are among those in the course of development at the present time.

The Land of Opportunity

Under the heading 'The Land of Opportunity', Godfrey Smith in the 1961 Directory of Opportunities for Graduates (Cornmarket Press Ltd.) has submitted to the Editor what are described as his findings on the subject of 'Opportunities for Graduates in America.'

This is a most humorous piece of writing as the following quotes willshow:

'*Aircraft Designers:* The natives adore flying, but their aircraft have a disconcerting tendency to come apart at the wings. The natives do not ground aircraft guilty of this strange deviation, owing to their belief in a curious religion known as *laissez faire*. Bomb-proof luggage racks are also urgently required; many natives play rather crude practical jokes on each other involving home-made explosives and attaché cases. Fatalities are all too common, and I am sure they could be minimized by lining luggage compartments with steel and asbestos.

'*Old Etonians:*. . . . Old Etonians are much in demand as butlers, doormen, lifeguards, commissionaires, and husbands. In all these categories they are certain to earn twice what they could have made as Third Secretaries in the Foreign Office, and in addition they will receive free uniform and many gratuitous invitations to lecture a powerful female tribe known as The Daughters of the American Revolution.

'*Psychiatrists:* There is a quick fortune here for any enterprising Englishman with a GCE 'O' level in biology. One of the female natives assured me in all seriousness that she had spent ten thousand dollars on psychiatric attention over recent years. She appeared perfectly normal to me, and I could not help reflecting that we could have put her on the road to recovery for only a fraction of that sum at Cheltenham with a few games of hockey and an occasional cold bath.

'*Vintners:* Wine is practically unknown to the natives. Down in West Virginia I was offered the local Burgundy, as they laughingly called it. I had been expecting it to tast faintly of vinegar; but frankly it never crossed my mind that it would taste like motor-mower oil.

'*Electricians:* The natives, with commendable ingenuity, have invented a device called the blab-off, which cuts out the sound when commercials are shown on their televison. It should not be beyond our resources, as the inventors of radar and other aids to humanity, to invent another device that would turn the programmes off too.'

Master and pupils at work with the electromagnet and electrodynamics equipment.

LABORATORY EQUIPMENT & APPLIANCES

A New Design in Electrophoresis

This apparatus, which has been developed in co-operation with the Courtauld Institute of the Middlesex Hospital Medical School, has been produced with the object of overcoming the many difficulties that have been experienced in this type of electrophoresis technique.

The tank is designed on the Flynn and Demayo principle with the following additional advantages:

1. The total volume of the tank has been reduced so that even saturation is ensured.

2. The base of the tank is in one solid piece of moulded polythene making it entirely leak-proof; it stands on four locating feet which facilitate transport from one position to another.

3. The hood is designed to ensure that no condensation drops on to the paper and, being detachable, makes for ease in the application of the samples on any portion of the paper.

4. The nylon thread, held under tension, prevents any sagging of the papers and the all-glass frame facilitates cleaning.

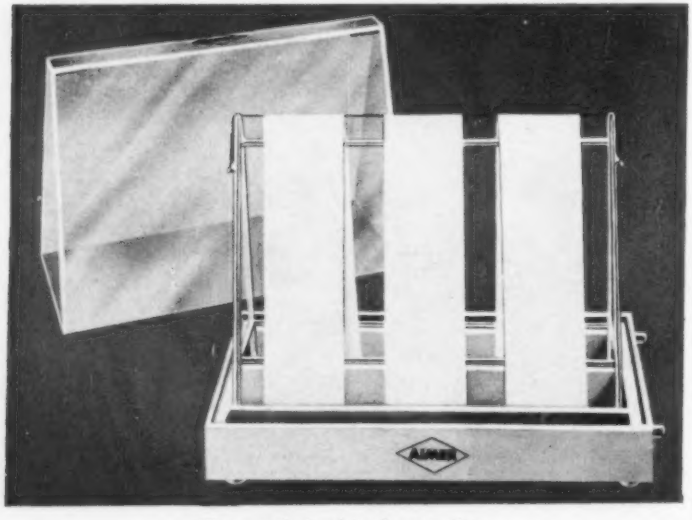
5. The glass frame can be removed from the tank and placed into a drying chamber, complete with the papers, so as to avoid handling saturated papers, which could easily be damaged, thus destroying important data.

6. Platinum electrodes are used and are found to be most reliable.

7. The size of the tank is 12 in. × 6 in. × 10 in. high and the glass frame can accommodate four paper strips 5 cm. wide.

The stabilized power unit runs between 30 and 350 volts at 0-25 mA—a range of voltage which is adequate for the usual electrophoresis techniques. It is capable of delivering sufficient power to run five tanks in parallel, each containing 3 × 5 cm. strips or equivalent.

(Manufacturers: Aimer Products Ltd., 56-58 Rochester Place, Camden Town, London, N.W.1.)



The new electrophoresis apparatus.

Multifix Multipurpose Apparatus

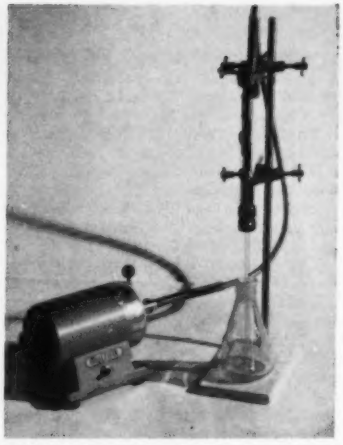
A set of multipurpose apparatus is now being marketed which brings in a compact and economical form many of the services regularly needed in all laboratories, including magnetic and direct stirring, vacuum compression and liquid pumping, and cork boring. In addition the same basic apparatus can be adapted to provide sawing, drilling, grinding and polishing facilities.

Quite apart from the obvious versatility of this apparatus, outstanding features are the infinitely variable speed of the motor (0-2,800 r.p.m. in either direction), the simple one-lever control for both forward and reverse action, and its high torque at low revolutions.

Additions will be made to the wide range of applications as further accessories are developed.

Although not necessarily the cheapest method of performing only one of its many functions, this Multifix apparatus is unquestionably a most economical way of carrying out several such operations.

(Manufacturers: Loughborough Glass Co. Ltd., Loughborough, Leics.)



Multifix apparatus in use for indirect stirring.

New Plastic Laboratory Taps

A completely new range of taps, cocks and fittings made for laboratory use are now being introduced into this country.

Moulded in nylon, various colours, in polythene and polypropylene, the wide range of designs available makes provision for practically every possible requirement. Manufactured in Germany, these new fitments are little dearer than traditional laboratory fittings and provide a modern approach with all the advantages inherent in the materials of their construction.

(Sole British Concessionaire: Tough Plastics Ltd., Byfleet Road, Addlestone, Surrey.)

Manufacturers are asked to co-operate by sending details and photographs of any new laboratory equipment and appliances they may produce.

Readers, when writing to manufacturers, are requested to mention LABORATORY PRACTICE.

NEWS

Personal Notes

Dr. C. E. K. Mees.

Dr. C. E. K. Mees, D.Sc., F.R.S., Hon. F.R.P.S., whose death occurred on August 15 at his home, in Honolulu, Hawaii, was an internationally famous scientist who devoted his life to research into and the development of the photographic processes.

He was born at Wellingborough on May 26, 1882, the son of a Wesleyan minister. He went to Kingswood School, Bath, and afterwards to St. Dunstan's College, where he met Samuel E. Shepherd, also a student. The two formed a lifelong friendship terminated only by Shepherd's death in 1948.

Both of them worked together at University College, London, on the theory of the photographic process under the guidance of Sir William Ramsey. On the basis of their study and research they received the degree of B.Sc. by research in 1903 and of D.Sc. in 1906. Their theses, published as a book 'Investigations on the Theory of the Photographic Process', were thereafter known to photographic workers as 'Shepherd and Mees'.

For the next six years Dr. Mees was a partner and joint managing director of an English photographic firm, Wratten & Wainwright Ltd., of Croydon, Surrey. During his first year there, he manufactured a successful series of panchromatic plates, light filters, and darkroom safelights. He later developed special plates for photo-engravers and spectroscopists and did research on the theory of photography, including the first measurements of the resolving power of photographic materials.

Dr. Mees accepted George Eastman's invitation to join Kodak in 1912, on the condition that the firm of Wratten and Wainwright was purchased at the same time, and he went to the company's Kodak Park Works, Rochester, New York, to organize and direct a research laboratory.

After the first World War he became Director of Research and Development for the company. Through his efforts and under his guidance the research laboratories grew enormously in extent and in the scope of their operations. In 1923 he was made a director of the company.

From the beginning of his early experimentation in photography Dr. Mees held to his aim of adding to knowledge of the scientific theory of photography. A milestone on this course came in 1942, with the publication of his book, 'The Theory of the Photographic Process', a compendium of photographic science. At the same time one of the clear goals of his applied research was to bring to as many people as possible the best in simplified cameras and good films for easy picture-taking. From the laboratories under his direction came outstanding research achievements, including home movies, panchromatic films, and processes of colour photography.

Mr. C. J. Grayston

The Balfour Group of Companies have appointed Mr. C. J. Grayston, M.I. Chem.E., as Group Research Director of their recently opened Research and Development Centre at Leven, Fife. He will have overall control of all sections of the enterprise.

One of Mr. Grayston's particular duties will be to supervise the Student and Graduate Apprenticeship Schemes which are now functioning within the Group, whereby young men and women can reach full professional status in the best possible conditions, while receiving industrial training.

Mr. Grayston has spent a lifetime in the Scott organization and is a director of George Scott & Son (London) Ltd., and Ernest Scott & Co. Ltd.

Mr. C. J. Grayston.

Manufacturers' News

Bencard Allergy Division

The S.I. Group have just completed the installation of laboratory furniture and fittings for the Bencard Allergy Division.

The work formed part of the reorganization and expansion of production facilities of this part of the Beecham Research Laboratories Ltd., on the Great West Road, and was under the direction of Mr. A. A. Jacobs, Manager of the Allergy Division.

West Instrument

West Instrument Ltd. of Brighton have opened a new sales and service office at 63 The Exchange, Mount Stuart Square, Cardiff (*Tel.:* Cardiff 23325). It is to be headed by Mr. L. G. A. Gabe, formerly an executive at the London office of Honeywell Controls.

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Another appointment is that of Mr. D. R. H. Lane who joins the London office staff of the company. He was formerly with Sperry Gyroscope where he was concerned with the test equipment for the Navy's guided missile, 'Sea-Slug'.

Mr. L. G. A. Gabe.

Smiths Link with Scandinavia

An agreement has recently been signed between Smiths Industrial Division and the ABEM Company, Stockholm, each company having appointed the other as sole distributor of their high speed pen recording and laboratory equipment in specified areas.

The ABEM Company, an old established organization well known in the geophysical world, has developed a range of scientific measuring instruments to support its geophysical work. This range embraces laboratory oscillographs, ultra-violet light recorders and direct writing recorders which use a heat sensitive paper as the recording medium. The Ultragraph, using ultra-violet light, incorporates moving coil mirror galvanometers of advanced design, and at recent international exhibitions this instrument has been particularly well received.

Smiths Industrial Division also market the Kelvin Hughes high speed pen recording equipment, thus the combined ranges of equipment of the two companies offer world industry complete coverage of high frequency recording.

Smiths Industrial Division will be the sole distributor of ABEM recording equipment in the United Kingdom, U.S.A., the Commonwealth and certain territories in Europe, while the ABEM Company will be the sole distributor of Kelvin Hughes recording equipment in Sweden, Norway, Denmark and Finland.

Both companies will be in close co-operation with each other on research and development.

Amberlite Ion Exchange Papers

By arrangement with the Rohm & Haas Company of Philadelphia, the B.D.H. Laboratory Chemicals Division has undertaken the marketing of the IERL (ion exchange resin loaded) papers recently introduced by the Rohm & Haas Company under their trade name 'Amberlite'.

These ion exchange papers will be marketed by B.D.H. exclusively in all countries other than the United States and Japan (where the arrangement does not apply) and Canada and Mexico, where the papers may also be marketed through other channels.

Change of Name

The analytical instrument activities of Southern Instruments Ltd. will in future be carried out in the name of Southern Analytical Ltd., a company newly formed for the purpose. Members of the board will include Mr. W. B. Horner, General Manager, Mr. H. M. Davis, B.Sc., A.R.I.C., A.Inst.P., Chief Engineer, late of UKAEA, and Mr. J. A. Colls, A.R.C.S., B.Sc. The Chairman is Mr. Philip Sellars, vice-chairman of Southern Instruments Ltd.

Publications

Diamino-Ethane-Tetra-Acetic Acid

The second edition of the book 'Analytical Applications of Diamino-Ethane-Tetra-Acetic Acid' (4s. 6d. net) has now been published by the British Drug Houses Ltd., of Poole, Dorset.

It has been revised and enlarged and now includes an appendix containing 12 new sections, in which recent developments in the use of conventional indicators, new visual indicators, and the use of amalgams are among the subjects dealt with. The book also contains a short bibliography on EDTA and more than 520 references to original papers.

Tinplate Testing

Tinplate Testing—Chemical and Physical Methods (55 pp.) by W. E. Hoare, D.Sc., F.I.M. and S. C. Britton, M.A., F.R.I.C., F.I.M., is written for those in the tinplate manufacturing and using industries, who are responsible for the quality appraisal of tinplate and the determination of the suitability of particular grades for specific uses. It is limited to what may be called the superficial layers of the tinplate so does not describe mechanical testing procedures.

Quality test methods for thickness and continuity of the tin coating, and the determination of the oxide and oil films are discussed and compared; also performance tests for rust resistance, staining, lacquerability, solderability and corrosion.

It is said that the pre-eminent characteristic is undoubtedly the thickness of the tin coating. Three of the 14 appendices describe thickness tests, the remainder deal with tests for the other qualities enumerated above.

Adequate detail is given, aided by 24 illustrations and diagrams, to enable laboratory technicians to mount and carry out the tests.

This handbook is obtainable free of charge from: The Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex, England.

Opportunities for Graduates

During the past year the number of men and women graduating from universities in Great Britain has increased at a much slower rate than the growth in the demand for their services from industry and the professions.

The number of graduates has gone up by only 7½ per cent while the number of industrial firms and government departments included in the Directory of Opportunities for Graduates has increased by 21 per cent from 275 to 332.

The aim of the Directory of Opportunities for Graduates (Commarket Press Ltd., 8s. 6d.) is to ease the flow of graduates from university to industry by providing the graduating student with up-to-date information about the firms which need him and the opportunities open to him.

The Preface to the 1961 edition is written this year by Viscount Boyd of Merton (formerly Alan Lennox-Boyd).

The editorial section contains an article by Kenneth Harris which introduces the graduate to the new world of industry, a survey by the Economist Intelligence Unit on different types of industry and the way they are growing, a bitingly humorous article by Godfrey Smith, and a series of individual case-histories showing what actually happened to eight young men after leaving university.

International Conferences

The Department of Scientific and Industrial Research has issued an addendum to List No. 27, Forthcoming International Scientific and Technical Conferences, for the period October-December 1960.

The new office and works of the Loughborough Glass Co. Ltd. The new building allows for further expansion in production and warehousing.

PHOTOGRAPHIC COMPETITION
THE ELGASTAT IN ACTION

Entries Close: 24th December, 1960

Prizes:

1st — £30 and Challenge Cup.
2nd — £25
3rd — £20
4th — £15
5th — £10

Additionally, 5 merit awards of £5 each.

Eligibility: Amateur photographers only. Employees of the Organizers, or their relatives, are excluded. There is no entry fee. It is regretted that the Organizers cannot answer any verbal or written enquiries in connection with this Competition.

Submission of Entries: These should be black and white on glossy paper $8\frac{1}{2}'' \times 6\frac{1}{2}''$. Any number of prints may be submitted. On the back of each should be the competitor's name, address, business appointment (if any), date, and place at which the Elgastat was photographed. Additionally, there should be a descriptive caption (see 'Judging'). The submission of photographs implies the right of the Organizers to reproduce and exhibit any prints either before or after final judging takes place, and that the owner of the Elgastat has no objection to this. The Organizers undertake to pay the sum of £2 for any photograph which has not received an award, but which is published in the Press.

Judging: The Elgastat should be shown in use with a descriptive caption (on back of photograph). Apart from setting and technique, the judges will assess the power of the photograph in conveying the theme—'The Elgastat in Action'. The panel will consist of three professional and three amateur photographers, whose decision shall be final.

Notification of Awards: The winners will be notified on or before 30th January, and all results will be published in Newsletters, 'Laboratory Practice', and various other journals.

Despatch of Entries: To reach the Organizers on or before 24th December, 1960. Envelopes to be marked 'Photographic Competition' and addressed to:

Miss P. M. Elton,
Elga Products Limited,
Lane End,
Buckinghamshire.

ELGA PRODUCTS LIMITED . LANE END . BUCKINGHAMSHIRE

Careers in the Scientific Industry

The Scientific Instrument Manufacturers' Association has published '*Careers in the Scientific Instrument Industry*', which gives a swift well-illustrated summary of what a new entrant into the industry can expect to find and what his work and training may be like.

The booklet of 20 pages has 42 photographs showing both many types of scientific instruments in action and skilled craftsmen constructing them and also assisting apprentices.

Plastics in the Tropics

A further report in this series, published for the Ministry of Aviation by H.M.S.O. (6s.) deals with polyvinyl chloride.

Thirteen batches of plasticized and four batches of unplasticized sheets of various proprietary grades of polyvinyl chloride (PVC) and related materials, and specimens of PVC covered electric cable and high tension cable were exposed for about two years at a number of sites in Nigeria. Dust and biological growth caused much staining of the sheet specimens at the jungle sites and at the desert site plasticizer exuded and the surfaces were covered with brown dust. Brass inserts corroded sometime during the exposure but only in one case, in the batch plasticized with di-octyl sebacate, was the corrosion persistent; staining of the sheets as a direct result of the corrosion of the inserts occurred on seven batches. At the three humid sites, five batches lost weight and two increased in weight during the trial. Changes in dimensions of the unplasticized batches were small at all sites. Three batches at the humid sites and one at the dry site showed an increase in tensile strength; most of the other specimens lost strength. Changes in electrical properties were small and such changes as did occur might be associated with damaged surfaces of the specimens.

The cable insulation remained in good condition throughout the trial under a variety of tropical conditions, including high humidity and strong sunlight. There was negligible physical damage other than that caused by termites; the insulation resistance, with one exception, remained good. The high tension cable which was used in the ignition system of a motor vehicle was in a very satisfactory condition after 33 months. Apart from slight abrasion, there was no sign of deterioration and the electrical properties remained constant.

Scientific and Technical Conferences

List No. 27—July 1960 issued by the Department of Scientific and Industrial Research amends and amplifies the information contained in List No. 26 which is now superseded. It contains a wide selection of forthcoming international scientific and technical conferences.

CATALOGUES, BROCHURES & LEAFLETS

Received from Manufacturers

B.D.H. Leaflets.—New entries in the catalogue of British Drug Houses Ltd., Poole, Dorset, are listed in the August issue of their monthly leaflet. These are as follows: *Organic and Inorganic Chemicals*—Glyoxylic acid; high purity metals; imino-diacetic acid and disodium salt. Other leaflets deal with tropical and standard grades of Ester wax 1960 and the determination of free and combined residual chlorine in water by means of the B.D.H. Lovibond nesslerizer.

Chemicals Catalogue.—A new catalogue has been produced by Gesellschaft für Teerverwertung m.b.H. from which it will be noted that a number of new coal tar chemicals have been added to their range. Copies of the new catalogue are available from the sole U.K. agents—Jacobson Van Den Berg & Co. (U.K.) Ltd., 3-5 Crutched Friars, London, E.C.3.

Organic Chemical Reagents.—Monograph No. 40 2:9-dimethyl-1:10- phenanthroline (Neocuproine), reagent for copper, has been published by Hopkin & Williams Ltd., of Chadwell Heath, Essex.

Biochemical Materials.—British Drug Houses Ltd. of Poole, Dorset, have issued a second and more comprehensive catalogue of B.D.H. Biochemicals. Many of the additional items relate to steroids and related substances.

The Quadrate Oven and Incubator.—This new combined oven and incubator, manufactured by Charles Hearson & Co., Ltd., of 68 Willow Walk, Bermondsey, London, S.E.1 is described in a leaflet which has just been issued by the company. It satisfies the requirements not only of educational and industrial laboratories, but all users where a small oven is required giving a wide temperature range and good control at low cost.

Gurr's New Price Lists.—George T. Gurr Ltd., of 136-140 New Kings Road, London, S.W.6, has just issued two new price lists. One deals with biological stains and reagents, including dyes for other scientific purposes, and the other with accessories for microscopy and biological science.

Laboratory Equipment.—The extensive list of products which can be supplied from stock is included in the new catalogue issued by the Loughborough Glass Co. Ltd., of Loughborough, Leics. Because their specialities have proved so popular, and their number has grown into a sizeable proportion of the company's range, the most important of these have been brought together at the beginning of this latest catalogue in a new Specialities Section. The main body of the catalogue remains in the convenient alphabetical order of earlier issues and within the following three sections: Interchangeable Laboratory Glassware, Plastics Laboratory Equipment, and General Laboratory Equipment.

Laboratory Porcelain.—The latest catalogue issued by the Worcester Royal Porcelain Co. Ltd., of 30 Curzon Street, London, W.1, contains details of the company's laboratory porcelain and alumina ware. This latter has been specially designed for high temperature use and is described for the first time in this catalogue.

Laboratory Instruments.—A wide range of leaflets has recently been issued by the Cambridge Instrument Co. Ltd., of 13 Grosvenor Place, London, S.W.1. These deal with draught and pressure instruments, Universal vibrograph, a pocket pH meter, pneumatic temperature measuring system, gas analysing apparatus, Huxley pattern ultramicrotome, electronic recorder-controllers, in-line scanning recorder, Microstep precision potentiometer, cardiograph electrodes, Numalec programme controller and an extrusion speed transmitter.

B.D.H. Leaflets.—New entries in the catalogue of British Drug Houses Ltd., of Poole, Dorset, are listed in the September 1960 issue of their monthly leaflet. These are as follows: *Organic and Inorganic Chemicals.*—Nickel sulphamate. *B.D.H. Amino Acids.*—DL-*ISO*-leucine. *B.D.H. Biochemicals.*—Amylopectin sulphate potassium salt.

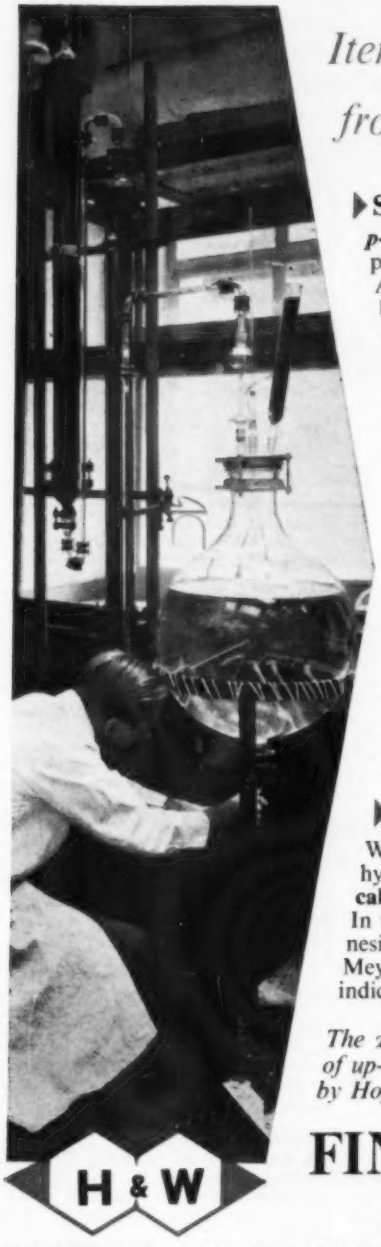
Hilger Journal.—A new automatic x-ray fluorescence spectrometer is the title of the main article in the latest edition of the Hilger Journal (Vol. VI, No. 2) published by Hilger & Watts Ltd. of 98 St. Pancras Way, Camden Town, London, N.W.1. Another article deals with the Ebert spectrograph and there are also the usual sections dealing with news and notes and abstracts from recent papers.

Stable Isotopes of Oxygen.—A leaflet containing scientific and technical information has been issued by the Weizmann Institute of Science, Rehovoth, Israel, describing the stable isotopes of oxygen which are widely used in research in physics, chemistry, biochemistry and biology.

Syringes and Pipettes.—Shandon Scientific Co., Ltd. of 6 Cromwell Place, London, S.W.7. have issued a leaflet describing their recently introduced ranges of microlitre syringes, gas-tight syringes and Lambda micropipettes.

Incidental Information

No. 14



Items of interest

from our laboratory notebooks

Simplified milk phosphatase test

***p*-Nitrophenylphosphoric acid, disodium salt** (*di*-sodium *p*-nitrophenyl phosphate) is used as a substrate in the **milk phosphatase** test of Aschaffenburg and Mullen now gaining in popularity and recognition because of its simplicity and speed. (See *J. Dairy Res.*, **16,** 58 (1949), and *Dairy Ind.*, **18,** 316 (1953)).

We make the reagent and can supply from stock. A suitable Lovibond Comparator for this test is obtainable from Baird & Tatlock (London) Ltd.

Karl Fischer catalyst

This well known method for the determination of **water** is widened in scope and increased in precision by the use of **Karl Fischer Catalyst** (*N*-ethylpiperidine)—available with instructions from Hopkin & Williams Ltd Please write for instruction leaflet.

Uranium by spectrophotometry

Our **1-(2-pyridylazo)-2-naphthol** (**PAN** for short), already known as a metal indicator for complexometric titrations, (H. Flaschka and H. Abdine, *Mikrochim. Acta*, 770 (1956); *Anal. Abs.*, **4,** 794 (1957)) is now described as a spectrophotometric reagent of high specificity for **uranium** (H. Shibata, *Anal. Chim. Acta*, **22,** 479 (1960)).

Sensitive reagent for Calcium

We also make **di-(*o*-hydroxyphenylimino) ethane** (glyoxal-bis-(2-hydroxy anil)), a specific colour reagent for microgram quantities of **calcium** in solution.

In the solid state calcium oxide can be detected in mixtures of magnesium, strontium and barium oxides. (D. Goldstein and C. Stark-Meyers, *Anal. Chim. Acta*, **19,** 437 (1958)). Its use as a complexometric indicator is described by Goldstein in *Anal. Chim. Acta*, **21,** 339 (1959).

The above are further examples of the great range of up-to-date reagents made available by Hopkins & Williams Ltd.

H & W

FINE CHEMICALS

for research, analysis and industry

HOPKIN & WILLIAMS LTD., CHADWELL HEATH, ESSEX, ENGLAND

Branches: London, Manchester, Glasgow *Agents throughout U.K. and all over the world*

TAS HW.13

MEETINGS FOR THE MONTH

Mid-November to Mid-December

We give below a selection of meetings of interest to laboratory workers. Details are as full as possible at the time of going to press, but readers requiring further information or confirmation of arrangements should contact the organizers.

November 8

The Institution of Chemical Engineers. At the Geological Society, Burlington House, London, W.1. 5.30 p.m. 'The Dynamic Response of a Distillation Column to Changes in the Reflux and Vapour Flow Rates,' by R. M. Wood and W. D. Armstrong. 'An Introduction to the Theoretical Evaluation of the Frequency Response of a Distillation Column to a Change of Reflux Flow Rate,' by R. M. Wood and W. D. Armstrong.

November 9

The Society of Instrument Technology (London Section). At Manson House, 26 Portland Place, London, W.1. 6.30 p.m. 'A Shaft Position Digitizer using Synchros.' by T. Roberts, B.Sc.

November 10

The Society of Instrument Technology (Liverpool Section). At M.A.N.W.E.B. Industrial Development Centre, Liverpool. 7 p.m. 'Some Recent Advances in Radiation Pyrometry,' by B. W. Barley.

The Society for Analytical Chemistry (Midlands Section). At Gosta Green, Birmingham. 7 p.m. Joint meeting with the Royal Institute of Chemistry on 'Analytical Problems in Forensic Toxicology,' by F. L. Cann, B.Sc., A.R.I.C.

November 11

The Society of Instrument Technology (Midland Section). In the Lecture Theatre of the Byng Kendrick Suite at the Gosta Green College of Technology, Aston Street, Birmingham. 6.30 p.m. 'The Common Sense Approach to Instrument Manufacture,' by C. E. T. Cridland, M.I.E.E.

The Society of Instrument Technology (Liverpool Section). Annual Dinner at 8 p.m.

November 14

The Society of Instrument Technology (Manchester Section). At the College of Science and Technology, Sackville Street Manchester. 6.45 p.m. 'Intrinsic Safety Requirements,' by H. C. Lister.

November 16

The Institution of Chemical Engineers (North Western Branch). At Lecture Theatre A, The Houldsworth School of Applied Science, Reservoir Street, Leeds, 2. 6.30 p.m. 'Electrical Hazards in the Chemical Industry,' by F. Clark.

November 17

The Society of Instrument Technology (London Section). At Manson House, 26 Portland Place, London, W.1. 6.30 p.m. 'The Control of a Single Effect Concentrating Evaporator—Dynamic Characteristics and Analogue Computer Study,' by F. P. Lees, M.A., B.Sc., L. W. A. Glasson, M.Eng. and J. A. Anderson, S.L.U.Ing.

The Society of Instrument Technology (East Midland Section). At Derby and District College of Technology, Kedleston Road, Derby. 6.45 p.m. 'The Wavelength Standard of Length.' by K. J. Hume, B.Sc., M.I.Mech.E., M.I.Prod.E.

The Society of Instrument Technology (Grangemouth Section). At the Leapark Hotel, Grangemouth. 7 p.m. 'Spectrophotometers,' by R. A. C. Isbell.

November 18

Royal Institution of Great Britain. At 21 Albemarle Street, London, W.1. 9 p.m. 'The Perception of Speech.' by D. E. Broadbent, M.A.

November 22

The Institution of Chemical Engineers (North Western Branch). At the Chemical Engineering Lecture Theatre, The Manchester College of Science and Technology, Jackson Street, Manchester, 1. 3.30 p.m. 'New Developments in the Bulk Supply of Chemical Reagents,'

The Society for Analytical Chemistry (Physical Methods Group). At the Meeting Room of the Chemical Society, Burlington House, London, W.1. 6.30 p.m. Annual General Meeting followed by an Ordinary Meeting on 'Atomic Absorption Spectroscopy.'

The Society of Instrument Technology (Cheltenham Section). At the Belle Vue Hotel, Cheltenham. 7.30 p.m. 'The Operation and Control of ERNIE.'

November 23

The Society for Analytical Chemistry (North of England Section). At Newcastle. Joint meeting with the Newcastle and North-East Coast Section of the Royal Institute of Chemistry on 'The Changing Aspects of Chemical Analysis,' by H. N. Wilson, F.R.I.C.

November 24

The Society of Instrument Technology (Chester Section). In the Lecture Theatre, Administration Building, The Associated Ethyl Company Ltd., Oil Sites Road, Ellesmere Port, Wirral. 7 p.m. 'Maintenance and Operational Experience of a Data Logging Installation,' by D. C. Austin.

November 25

The Society of Instrument Technology (Scottish Section). At Glasgow University. 7.15 p.m. 'Instrumentation of a Space Vehicle,' by A. E. Roy, B.Sc., Ph.D., F.R.Ae.S.

Royal Institution of Great Britain. At 21 Albemarle Street, London, W.1. 9 p.m. 'Frédéric Chopin: The Man and the Artist,' by Arthur Hedley.

November 29

The Society of Instrument Technology (London Section). At Manson House, 26 Portland Place, London, W.1. 6.30 p.m. Symposium on Nuclear Temperature Scanning.

December 1

The Society for Analytical Chemistry (Scottish Section). At Glasgow. The Ramsay Dinner.

December 2

Royal Institution of Great Britain. At 21 Albemarle Street, London, W.1. 9 p.m. 'Control, Constancy and Change in Animal Life,' by J. Z. Young, M.A., F.R.S.

The Society for Analytical Chemistry (Scottish Section). At the Royal College of Science and Technology, Glasgow, C.1. Joint meeting with the Chemical Society, the Society of Chemical Industry and the Royal Institution of Chemistry, addressed by the President of the Society, Mr. R. C. Chirnside, F.R.I.C.

December 3

The Society for Analytical Chemistry (North of England Section). At the City Laboratories, Mount Pleasant, Liverpool. 2.15 p.m. 'Some Experiences in the Estimation of Metals in Foodstuffs,' by H. Pritchard, M.Sc., F.R.I.C.

December 5

The Society of Instrument Technology (South Yorkshire Section). At the University, St. George's Square, Sheffield 1. 7 p.m. 'Instrumentation for Railway Research,' by P. H. Mansfield, B.Sc., A.M.I.E.E.

December 6

The Institution of Chemical Engineers. At the Geological Society, Burlington House, London, W.1. 5.30 p.m. 'Study on Electro-precipitator Performance in Relation to Particle Size Distribution, Level of Collection Efficiency and Power Input,' by D. O. Heinrich.

December 7

The Institution of Chemical Engineers (Midlands Branch). At the Midland Hotel, Birmingham, 6.30 p.m. 'Noise Problems in a Large Refinery,' by M. B. Shirley.

The Society for Analytical Chemistry (London). Meeting on 'The Flask Combustion Technique.'

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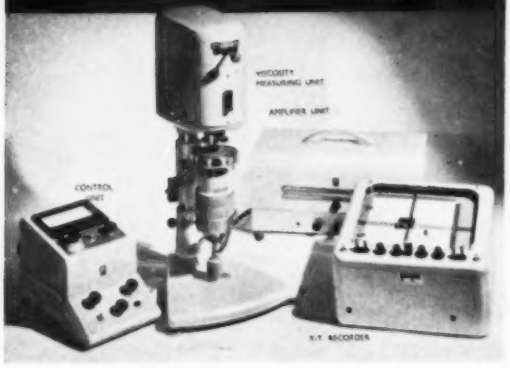

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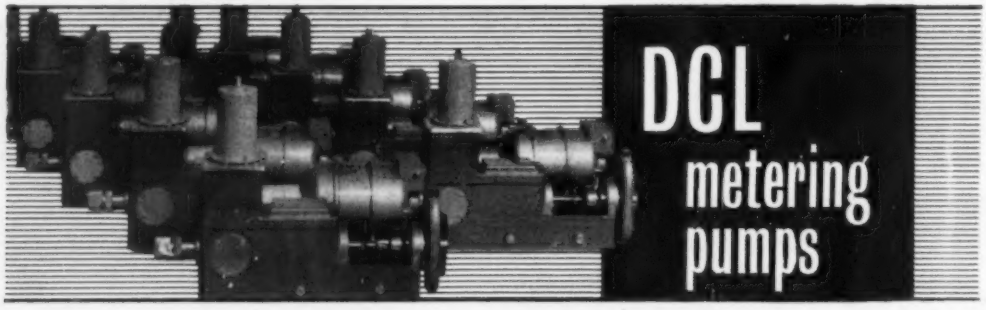

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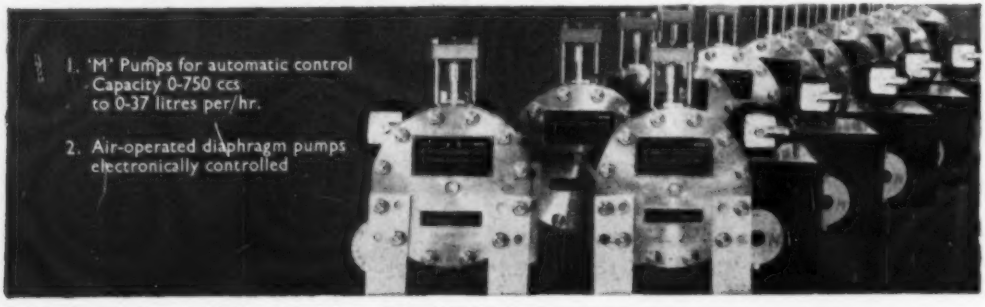

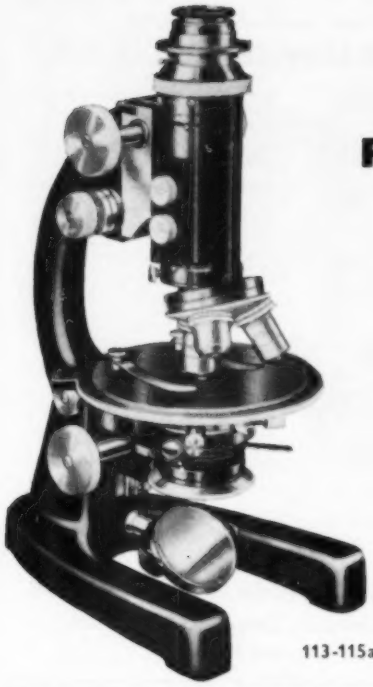

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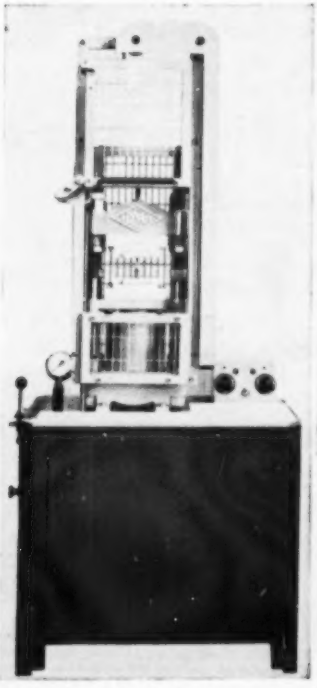

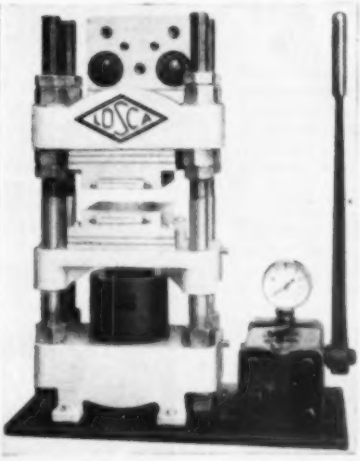

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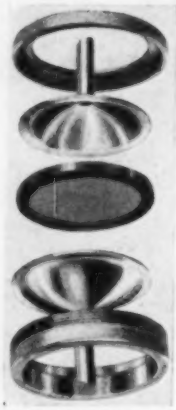

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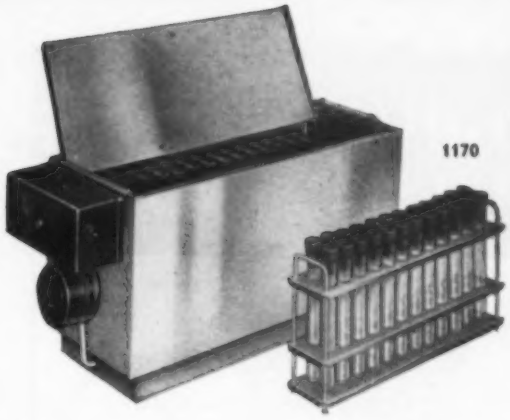

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1,000	.158	.224	.274	.316	.388	.474	.548	0.708
1,500	.129	.183	.224	.258	.316	.387	.447	.578
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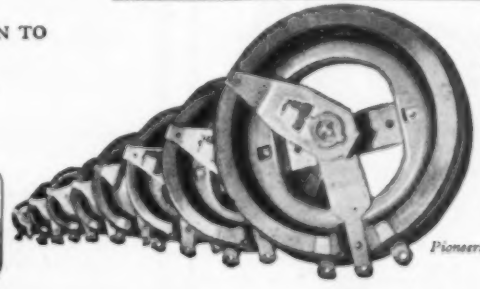

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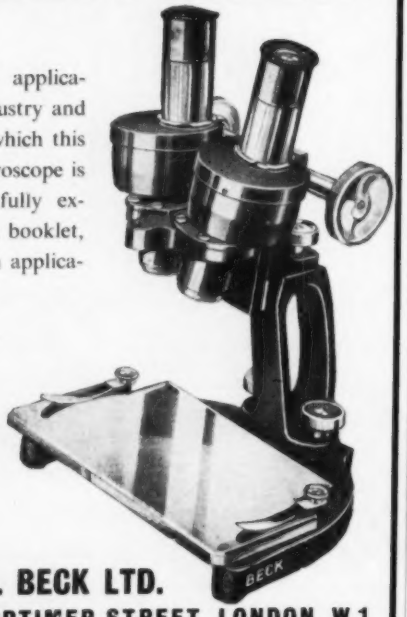

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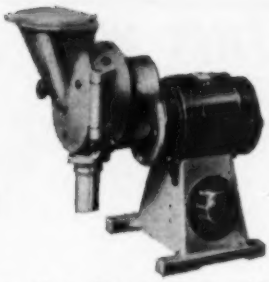

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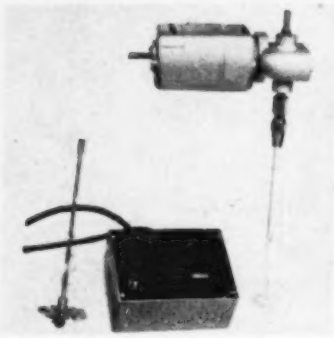

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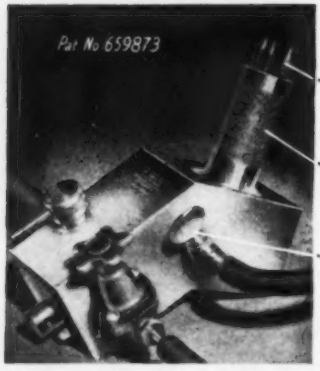

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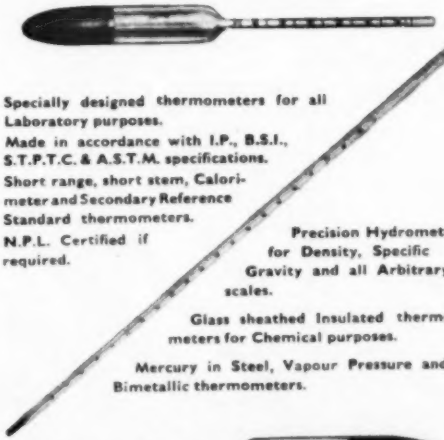

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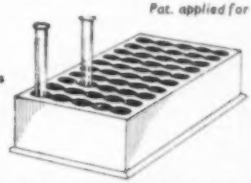

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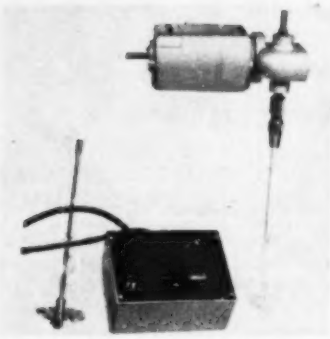

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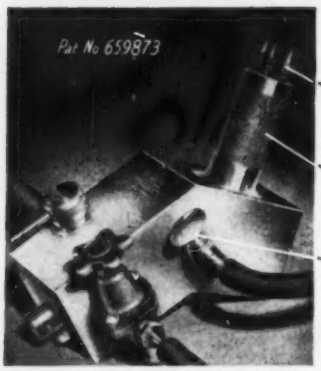

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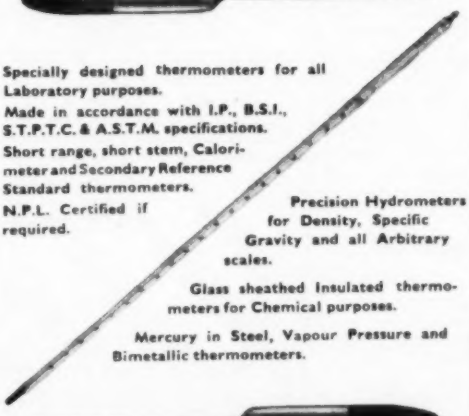

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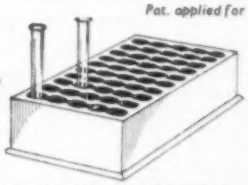

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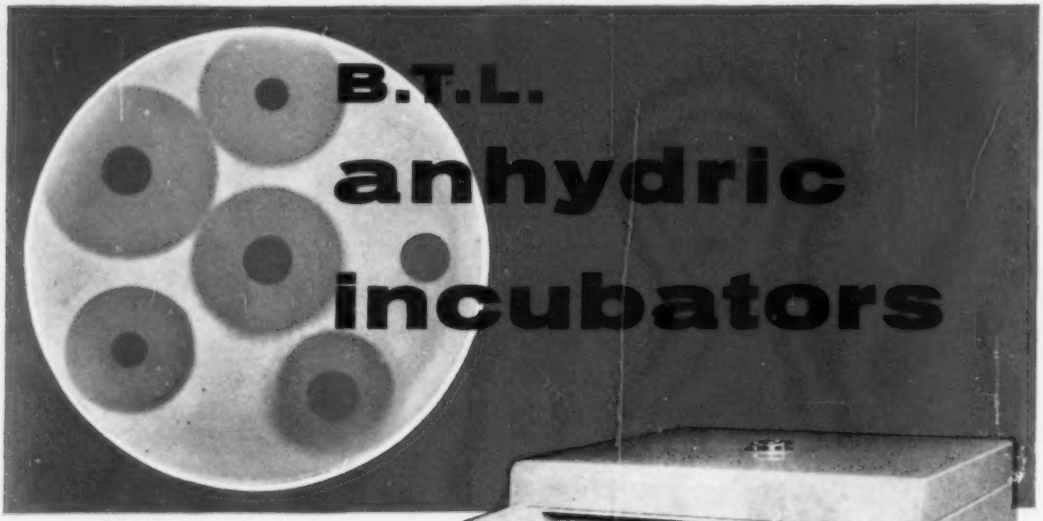

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